

INDIGENOUS DRUGS OF INDIA

REVISED AND LARGELY RE-WRITTEN BY

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To
Professor M. S. Thacker
for his Great Interest in Indian Medicinal Plants

PREFACE TO THE FIRST EDITION

Although in the past a number of treatises on the subject of the Indian Indigenous Drugs have appeared, no apology is needed for presenting a new book to the reader. The subject is old, but it has not lost its interest with time. On the other hand, there is reason to believe that it is attracting more attention from the medical profession and the general public. It is thought that from the vast array of the *materia medica* of the indigenous systems, investigation and research might bring to the scientific world many useful remedies for the alleviation of human sufferings. Although a systematic study of the indigenous drugs was begun nearly a century ago and admirable attempts were made by the early European and Indian workers, the progress has been slow. The reason is not far to seek. Scientific methods of chemical investigation of plants have only been known during the last thirty years or so. Properly equipped laboratories for carrying out the physiological and pharmacological tests did not exist in India till recently, and lastly the critical evaluation of therapeutic remedies was not possible for want of suitable research hospitals. As the Professor of Pharmacology at the Calcutta School of Tropical Medicine and as a Physician to the Carmichael Hospital for Tropical Diseases, I have had the good fortune of not only having well equipped chemical and pharmacological laboratories at my disposal, but also facilities for carrying out clinical trials. Collaboration with and help of colleagues at the School, experts in all the various important branches of medicine, made the task less difficult. The generous grants given to me by the Indian Research Fund Association enabled me to study these drugs through all the different stages.

In this volume an attempt has been made to present these observations to the medical profession, research workers, pharmaceutical chemists and manufacturers. Though the book has been based mainly on the work done by myself and my colleagues in the Department of Pharmacology and Chemistry, a résumé of practically all recent investigations on the subject of Indian Indigenous Drugs has also been included for the convenience of the reader.

The book is divided into five parts. The first part is entirely devoted to general considerations regarding the necessity of research into the vast domain of the indigenous drugs, with special reference to the problems which presented themselves to me during the course of this work. The term 'indigenous drugs' has been used in a comprehensive sense and has been taken to include not merely those drugs which were originally the natives of India, but also the exotics which have been cultivated at some time or other and have become completely naturalised to the soil. The lines on which efforts of the worker should be directed in order to achieve useful results have been clearly indicated. The methods of effecting economy so as to bring the treatment of disease within the means of the poor masses in India, and the desirability of using crude drugs, which are cheaper, in place of the refined and finished preparations, have been discussed. A special reference has been made to the cultivation of important medicinal plants in India. This part, it is confidently hoped, will provide much food for thought to all those

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who are interested in the study of the Indian medicinal plants and in making the country self-supporting so far as the medicinal drugs are concerned.

The second part deals with the pharmacopoeial and allied drugs. No effort has been made here to present the botanical, chemical, pharmacological and therapeutic details which can be found in any of the standard works. It has been my aim throughout this section to draw the attention of the reader to the enormous possibilities which exist with regard to this group of drugs and which if worked up might be of great economic benefit to the country. This phase of the problem of the indigenous drugs has thus far received little or no attention from the professions of medicine and pharmacy in our country.

The third part deals with the drugs used in the indigenous medicine. The chief object here has been to present to the reader a short account of the chemical composition, the pharmacological action and therapeutic uses of these drugs. This, it is hoped, will help the medical practitioners and others interested to judge the merits and demerits of a particular drug and to decide whether to use it or not. No attempt has been made in this section to give all the general information available in the old literature. For such information the reader is referred to such excellent works as Dymock's *Pharmacographia Indica*, Watt's *Dictionary of the Economic Products of India*, Kirtikar and Basu's *Indian Medicinal Plants*, etc. Nor is it intended to enter much into the province of the systematic botanist and pharmacognosist. Only such botanical and descriptive data have been given as are absolutely necessary for ordinary purposes.

In Part IV a glossary of all medicinal plants growing in India has been given. This is by far the most complete list so far prepared and includes over two thousand plants. The active principles contained and the purposes for which they are used in the indigenous medicine are briefly indicated. References to any work published are given. In addition to medicinal plants this part contains a short description of drugs of animal and mineral origin used in the indigenous systems of medicine. Lists of plants containing poisonous principles and plant remedies used in the treatment of snake-bite and scorpion-sting have been included.

Part V gives a short description of the common bazar medicines of India, their important vernacular names and their popular uses. After this a separate index of the commonly used vernacular names has been provided. This will enable the reader to trace a drug if he knows one of the common names by which it is known in any part of India.

The present volume owes its inception to an invitation extended to me by the Patna University to deliver a course of lectures in connection with the Sukhraj Ray Readership in Natural Science during 1929-30. The medical and economic aspects of some Indian medicinal plants formed the theme of these lectures. The interest evinced in the subject has been shown by the fact that letters and enquiries have been pouring in from all parts of India. For this reason the idea of extending the scope and presenting the subject matter in book form was conceived. This idea, however, could not be put into a practical shape for some time as I went on deputation as Chairman of the Drugs Enquiry Committee appointed

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by the Government of India to consider the question of the quality of medicinal drugs on the Indian market. Personal contact with the professions of medicine and pharmacy during my all-India tour further impressed on me the necessity and utility of such a publication. On the nucleus of the Patna lectures, therefore, the present superstructure has been built. In its general plan and arrangement, the present volume bears a close resemblance to the lectures originally delivered but considerable amount of new material has been added. I take this opportunity of conveying my deep sense of appreciation to the authorities of the Patna University.

I have very great pleasure to acknowledging the assistance I have received in writing this book from Dr. B. Mukherji, my former pupil and now my assistant in the department of Pharmacology and Dr. S. Ghosh, Professor of Chemistry. But for the great interest taken in this work by all the members of the staff of the two departments it would not have been possible for me to complete the work in such a short time. They have helped in the compilation of the list of indigenous drugs, in the collection of references and in the preparation of the index. This has been a very tedious and laborious work. Dr. I. B. Bose has rendered valuable assistance in finally checking references, scrutinizing the proofs and in getting the book through the press. To all these workers I am very grateful. To Dr. L. E. Napier and Lieut.-Col. R. Knowles I owe a great debt of gratitude for the critical reading of the proofs and for valuable suggestions which have saved the book from many blemishes. I wish to convey my deep sense of appreciation to Lieut.-Col. H. W. Acton, C.I.E., I.M.S., Director of the School of Tropical Medicine, who initiated me to research, the outcome of which is the present volume. His advice at every stage of this work has been invaluable. I also wish to place on record the encouragement given to the study of the Indian Indigenous Drugs by the Governing Body of the Indian Research Fund Association, Major-General J. W. D. Megaw, C.I.E., K.H.P., I.M.S., formerly Director of the School and now the Director-General of the Indian Medical Service, and Major-General J. D. Graham, C.B., C.I.E., K.H.S., I.M.S., Secretary of the Association. To the editors of the *Indian Medical Gazette* and *Indian Journal of Medical Research*, the two periodicals in which most of my work on the indigenous drugs has been published, I am grateful for permission to make use of the papers for the purposes of the book. Those who are interested in details of this work would be well advised to read the original papers, references to which are all given in the book. To Mr. N. Mukherjee and staff of the Art Press I am grateful for the care they have bestowed in printing and publishing this volume.

School of Tropical Medicine
Calcutta

R. N. CHOPRA

November, 1932

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PART I

THE MEDICAL AND ECONOMIC ASPECTS OF INDIAN INDIGENOUS DRUGS

I

Historical and General.—It is desirable to point out at the outset that the term 'Indigenous Drugs' has been used in its widest sense so as to include within its scope not merely those drugs which were originally the natives of India but also those which have been introduced from outside and have become completely naturalised. Drugs which are cultivated in India, whether used in the indigenous systems of medicine or in the pharmacopoeias of various Western countries have also been brought within the purview of that expression.

The Indian indigenous drugs have great importance both from the professional and economic points of view. Medicine is a very ancient art, and drugs have been used in days of antiquity as far back as history can take us. It is impossible to think of medicine as something not connected with treatment, and drugs have formed an integral part of treatment from the commencement of human memory.

THE ANTIQUITY OF INDIAN MATERIA MEDICA.—The history of medicine in India can be traced to the remote past. The earliest mention of the medicinal use of plants is to be found in the Rigveda, which is one of the oldest, if not the oldest, repositories of human knowledge, having been written between 4500 and 1600 B.C. In this work mention has been made of the Soma plant and its effects on man. In the Atharvaveda, which is a later production, the use of drugs is more varied although it takes the form, in many instances, of charms, amulets, etc. It is in the Ayurveda, which is considered as an Upaveda (or supplementary hymns designed for the more detailed instruction of the mankind), that definite properties of drugs and their uses have been given in some detail. Ayurveda, in fact, is the very foundation stone of the ancient medical science of India. It has eight divisions which deal with different aspects of the science of life and the art of healing. The age of Ayurveda is fixed by various Western scholars somewhere about 2500 to 600 B.C. The eight divisions of the Ayurveda were followed by two works written later, i.e., Susruta and Charaka. About the date of Susruta there is a great deal of uncertainty but it could not have been written later than 1000 B.C. In this work surgery is dealt with in detail but there is a comprehensive chapter on therapeutics. Charaka, written about the same period, deals more with medicine and its seventh chapter is taken up entirely with the consideration of purgatives and emetics. In the twelve chapters there is to be found a remarkable description of materia medica as it was known to the ancient Hindus. The simple medicines alone are arranged by this author under forty-five heads. The methods of administration of drugs are fully described and bear a striking resemblance to those in use at the present

time; even administration of medicaments by injections for various diseased conditions has not failed to attract notice and attention. From *Susruta* and *Charaka* various systems dealing with different branches of medicine sprang up. Dr. Wise (1845) mentions two systems of Hindu surgery and nine systems of medicine, three of *materia medica*, one of *posology*, one of pharmacy, and three of metallic preparations alone. From these one can gather the strength and dimensions of the scientific knowledge of ancient India regarding therapeutic agents both of organic and inorganic origin. Even anaesthetics in some form or other were not unknown. 'Bhoja-prabandha', a treatise written about A.D. 980 contains a reference to inhalation of medicaments before surgical operations and an anaesthetic called 'Sammohini' is said to have been used in the time of Buddha.

From this period down to the Mohammedan invasion of India, Hindu medicine flourished. Its progress may briefly be traced through four distinct stages, namely (1) the Vedic period, (2) the period of original research and classical authors, (3) the period of compilers and also of Tantras and Siddhas (Chemist-physicians), and (4) the period of decay and recompilation. During the second and third periods the progress was remarkable in every respect and *Ayurveda* then attained its highest development. Towards the close of this period *Ayurvedic* medicine made its way far beyond the limits of India. The nations of the civilised world of that time eagerly sought to obtain information regarding the healing art from the Hindus of those times, the influence of Hindu medicine permeated far and wide into Egypt, Greece and Rome and moulded the Greek and Roman medicine and through the former, Arabic medicine also. Jacolliot very rightly and pertinently remarked, "We should not forget that India, that immense and luminous centre in olden times, was in constant communication with all the peoples of Asia and that all the philosophers and sages of antiquity went there to study the science of life". There are unmistakable evidences in the Grecian and Roman medicine of the influence of Hindu medicine. Hellenic civilisation came most intimately in contact with Indian civilisation through the conquests of Alexander the Great. During this period Indian medicine was at its zenith and the knowledge of the Hindu physicians in the domain of drug therapy and toxicology was far in advance of others. They made an intensive study of the properties of every product of the soil and systematically devoted their attention to the study of disease and its treatment with drugs. The skill of these physicians in curing snake bites and other ailments among the soldiers of the Grecian camp bears testimony to this. No wonder then that the Grecian medicine imbibed in a large measure the knowledge of the healing science and enriched its *materia medica* from those of the Hindus. There is reason to believe that many Greek philosophers like Paracelsus, Hippocrates and Pythagoras actually visited the East and helped in the transmission of Hindu culture to their own countries. The work of the great physician Dioscorides definitely shows to what extent the ancients were indebted to India and the East for their medicine. Many Indian plants are mentioned in his first work, particularly the aromatic group of drugs for which India has always been famed. The smoking of *datura*

in cases of asthma, the use of *nux vomica* in paralysis and dyspepsia, and the use of *croton* as a purgative can be definitely traced to have originated from ancient India. Even the effects produced by excessive smoking of *datura* came to their notice.

The Romans also took a great interest in Indian drugs. There is evidence to show that an extensive trade in Indian drugs existed between India and Rome many centuries ago. The country, with enormous variabilities of climate and with such wonderful ranges of mountains as the Himalayas, was from the earliest times, recognised as a rich nursery of the vegetable *materia medica*. In the days of Pliny, this drug traffic assumed such enormous proportions that he actually complained of the heavy drain of Roman gold to India in buying costly Indian drugs and spices. The following extract from the writing of an English student of Oriental literature will be of interest in this connection. In the course of a lecture, Captain Johnston Saint, mentioned the extraordinary advance made both in surgery and medicine in India when Europe was groping for light in her cradle in Greece. Says he "If then this is what we found in surgery, what may we not find in medicine from India—that vast and fertile country which is a veritable encyclopaedia of the vegetable world. The *materia medica* of the ancient Hindus is a marvel from which both the Greeks and the Romans freely borrowed"

II

Evolution of the Present Indian Indigenous Drugs.—DECAY OF INDIAN MEDICINE.—After the period of the Tantras and Siddhas, the glories of the Hindu medicine rapidly waned and declined. During the invasion of India by the Greeks, Scythians and Mohammedans successively, no original works were written and the Hindu medicine gradually began to decay. During the disturbed times that followed, a good deal of the existing Ayurvedic literature was mutilated or lost, and degeneration became discernible everywhere. Various branches of medicine passed into the hands of priests, and drugs and herbs gave way to charms and amulets. The medicine man himself became a member of a subcaste of Brahmins to whom knowledge and learning were chiefly confined. A large section of them began to think that the study and practice of the healing art, specially surgery, led to pollution. To touch the dead body was considered sinful and, dissection of dead bodies being discontinued, advancement in anatomical and surgical knowledge naturally declined. The Buddhistic doctrine of 'Ahimsa' also exercised a great influence in that direction. Though surgery declined to a great extent during the Buddhistic period, medicine again made rapid progress. It was in this period that a large number of valuable drugs were added to the already extensive *materia medica*, and drugs began to be systematically cultivated and investigated. With the decline of Buddhism, degeneration set in all round—in knowledge, learning and practice of both medicine and surgery—and the process of decay became well advanced about the time of the Mohammedan invasion.

With the advent of the Muslim conquerors, the decline was even more rapid. The invaders brought their own healing system, which was fairly advanced for that period, and as the Mohammedan rule became established, the old Hindu or the Ayurvedic system of treatment was rapidly thrown into the background. The Arabic system thus introduced, became the state system of relief. Professor Brown, in his lectures delivered before the Royal College of Physicians, showed how greatly Arabian medicine was influenced by the Greek learning in the early centuries of the Christian era. Although the chief pursuit of the chemists about this time was the Philosopher's Stone and the Elixir of Life, they nevertheless made many real discoveries. How many of these we owe to the Arabs is apparent from such words as alcohol, alembic and the like, still current at the present time. There is no doubt that it was in the domain of chemistry and *materia medica* that the Arabs added most to the body of scientific doctrine which they inherited from the Greeks. Leclerc in his '*Histoire de la Médecine Arabe*' points out that even a century earlier than the Arab conquest of Egypt, the process of assimilating the Greek medicine had begun. The Arabian medicine was also influenced by the Persian Jundi-Shapor School which flourished in Persia in the fifth century A.D. This is evident from the fact that there is undoubtedly a Persian element, especially in *materia medica*, in which the Arabic nomenclature plainly reveals, in many instances, Persian origin. About the middle of the eighth century, when the city of Bagdad was newly founded, the great stream of ancient learning began to pour into the Mohammedan world and to reclothe itself in Arabian dress. The Mohammedan system of medicine thus brought with it a rich store of its own *materia medica*, quite unknown to the country.

ADVENT OF ARABIAN AND WESTERN MEDICINE.—The Arabian or the Mohammedan medicine prevalent during the reign of the Pathan and Moghul dynasties unfortunately did not make much progress after its introduction into the country and with the fall of the Moghuls it rapidly decayed. During the intimate contact between the old Hindu medicine and the Arabian medicine, which lasted for many centuries, there was a great deal of intermingling and each utilised the *materia medica* of the other. The result was that, though both the systems had declined, a rich store of the combined *materia medica* was left behind. With the advent of Europeans—first the Portuguese, then the French and lastly the English—the decline was still further marked.

When the British rule was established, the Western system was introduced and it was primarily intended to give relief to those who administered the country. As there was no proper system of medical relief in vogue at that time, the newly introduced Western system found its way amongst the people and was welcomed by them; the appreciation and the demand for it extended all over the country, especially as its surgical achievements appealed strongly to the people and made a great effect on them. It also brought with it its own *materia medica* and there was further intermingling and introduction of new medicinal plants into the country.

This, in brief, is the story of the evolution of what are commonly known as the Indian indigenous drugs. A combination of all drugs from the three sources constitute the Indian indigenous drugs with which we are concerned today.

III

Attempts at Revival of Indigenous Systems.—The Indian systems of medicine have been regarded by many of the Western scholars interested in Oriental studies as a rich mine of knowledge from which many useful things might possibly be unearthed. It has been said that the medicine of India was permeated with the scientific spirit as evidenced by a desire, by observation and experiment, by induction and deduction, to probe the secrets of nature and to build thereon a rational system of medicine. On the other hand, contrary opinion is also not wanting that no benefit will be derived by a study of the old systems which are based mainly on empiricism rather than science. This reasoning, however, does not seem to be based on sound logic. A system which has survived to such an extent the ravages of time, cannot be entirely brushed aside as unscientific. The opinion of Dr. Hugh S. Cumming, a former Surgeon-General of the United States Public Health Services, is worth recalling in this connection. He has expressed the belief that any system of medicine or, for that matter, any ancient usage or custom that has held its own for generations usually has something at the back of it, no matter how little it appears to be supported by modern science. According to him, for generations the fact that the American Indian hunters always chose the liver and the white men the meat when the animals they had trapped or killed were divided, was quoted as proof of their ignorance and primitive development. Yet the great nutritive value of liver has come to be recognised and its value in treatment of anaemia is now established. In the light of these and other facts, old systems cannot be summarily condemned as useless and would form fitting subjects for enquiry and investigation.

Of late years, a spirit of enquiry and research into the ancient systems has been discernible among the people of the soil. Even a distinct reaction in favour of the revival of old systems has been apparent in many parts of the country. As a result of this, considerable interest has been evinced by the public and by the medical profession regarding the use of indigenous drugs in the treatment of disease. Indeed it has been argued that, apart from economic considerations, these drugs are more suited to the habits of the people and the climatic conditions that prevail in this country. The question of the restoration and development of the indigenous systems of medicine has been discussed by the legislatures of the various States of the Union. It has been argued that no more than 20 per cent. of the population of this vast country even now have access to the Western scientific medicine and that the remaining have to rely on the old systems in some form or other and on the indigenous materia medica. This fact was fully appreciated by the authorities concerned. Lord Hardinge, in the course of an

address, said, "When I remember how many millions of people in India are beyond the reach of allopathic aid provided by the Government and how many of those who had means of access to consult the best doctors still prefer to be treated in accordance with the indigenous systems of medicine, I come to the conclusion that I should be wrong to discourage the scheme which aims at improvement and development of this branch of medicine".

The difficulties, however, in the wholesale revival and development of these systems are very great and are freely acknowledged even by the learned exponents of these systems. When it is remembered that the Ayurvedic system of medicine has been practically stationary for about fifteen hundred years and that no attempt has been made to advance the knowledge in conjunction with the progress of the world, one would find it very difficult to reconcile the old theories of two thousand years ago, however much one may stretch their significance, with the recent advance of the world in science. After imparting instruction to the Ayurvedic students in modern physiology, bacteriology, pathology, etc., to ask them to apply the doctrine of *vayu*, *pitta*, *kapha*, etc., to explain the causation of disease, might not be convincing to them and might bring nothing but chaos and discord to their minds. The students trained under such a system might neither be good at one nor the other. The same is the case with the Mohammedan medicine. Attempts at the revival of these systems in their present form are bound not to succeed.

IV

Necessity for Research in Indigenous Drugs.—While it is not our object here to consider the merits of such revival we have no doubt that out of the large number of drugs used by the Kavirajes and Hakims for centuries past and still in use, there are many that deserve the reputation they have earned as cures. History shows that many of our important pharmacopoeial drugs were known and were also used in some form or other possibly long before they were introduced into the Western medicine and before their actions were investigated on scientific lines. On the other hand, there are sure to be others of little therapeutic value that are given merely because they are mentioned in some old manuscripts, and no one has taken the trouble to confirm the truth of these statements. Attempts must be made to separate the good ones from the useless ones and for this a systematic investigation of these drugs must be undertaken. Medicine is a progressive science; in every department an attempt is being made to replace empiricism by rationalism and nowhere is this more evident than in the science of pharmacology and therapeutics.

Thus, when it is said that a drug like *Saraca indica* (Asoka) is useful in menorrhagia or *Cephalandra indica* (Telakucha) in diabetes, or *Bærhoavia diffusa* (Punarnava) in dropsy, the profession will not accept these assertions, as these are symptoms and signs and not diseases; what we want to know is their particular value in these various conditions and how they help to restore the tissues to their

normal condition. The scientific mind is not satisfied by mere statements, no matter from what source they originate, unless corroborated by clinical and experimental evidence. This of course necessitates careful and laborious work, which means time and extensive study. The active principles responsible for the therapeutic action have to be isolated and worked out. The way in which the effect is brought about and the manner in which the important organs of the body are affected has to be determined by animal experiments. The question of making suitable preparations and their preservation so as to make their potency independent of climatic and seasonal variations next assumes prominence. The standardisation of drugs and preparations by chemical and biological methods of assay is an important factor to secure therapeutic uniformity so that the amount of active principle in each dose is not subjected to irregular variations. These variations, for obvious reasons, are most undesirable and many do more harm than good, especially when one is dealing with potent drugs. Fresh juices and decoctions may be efficacious but, for all practical purposes, their utility must necessarily be limited. Until these drugs are investigated on rational lines, their use by the profession in India must be restricted; while other countries not bound by these traditions will only use them when their utility is brought home to them by convincing proof.

Much more could be done in furthering the cause of indigenous medicine and making it really useful to the people in this country by a thorough study of the indigenous drugs than by wholesale revivals of the old system under vastly changed environments. The active and useful drugs should be separated from those which are inactive and worthless, and they should be brought into use for relieving the sufferings of the vast masses of humanity in this country. The economic condition of the people is so low that they often cannot afford to use the expensive medicines of the Western system which are imported from outside. The result is that the majority of the people have either to go without them or rely on the crude drugs sold in the bazar, many of which are active, while others are devoid of the therapeutic activity they are alleged to possess.

V

Value of Research in Indigenous Drugs.—The question may be asked what is the value of research in Indian Indigenous Drugs? During recent years chemistry has made rapid strides and remarkable progress has been recorded particularly in the field of synthetic chemistry. Chemists have synthesised very potent and effective remedies such as arsenicals and antimalarial compounds for the treatment of protozoal diseases and sulphonamides for the treatment of bacterial diseases. The group of antibiotic drugs have revolutionised the treatment of many bacterial and rickettsial diseases and even some of the virus diseases are being touched. The diseases which were considered inaccessible a little while ago are now easily cured by their means. In view of all this, is there any necessity for going on with research on indigenous drugs? Will it lead to much? Will we get anything by going on with this expensive and time-consuming work?

The reply to these questions has lately been given in the Editorial comments in the well-known and eminent Journal of Practical Medicine, *The Practitioner* in its issue of December, 1950. Under the heading 'Indigenous Herbs' it says, "The wise and experienced clinician never spurns an 'old wife's tale' until he has good evidence for doing so. The lore of the countryman is built upon the experience of generations—often of centuries—and the data upon which it is based have often been obtained at a price in human lives which no modern research worker would ever dream of considering. It is particularly appropriate at the present moment, when the pharmaceutical companies of the world are emitting an unceasing flow of new synthetic drugs, that attention should be turned to the possible remedies that may be found among indigenous herbs of this and other countries. Four examples of such research proving fruitful may be recalled. In eastern Mediterranean countries and in Arabia the local physicians often prescribe a decoction of the dried seeds of a local plant, *Ammi visnaga*, as a diuretic and as an antispasmodic in renal colic. Investigations by G. V. Anrep and his colleagues in Cairo (*Brit. Heart J.*, 1946, 8, 171) showed the active constituent to be *Khellin*, which they found to be an effective vasodilator with a selective action on the coronary arteries. Subsequent clinical trials demonstrated the value of *Khellin* in the treatment of angina pectoris. From ancient times the root of an indigenous plant, *Rauwolfia serpentina*, has been widely used in India and Malaya as an antidote to insect and snake bites, as a febrifuge, as a stimulant to uterine contraction, and as a sedative. R. J. Vakil (*Brit. Heart J.*, 1949, 11, 350) investigated its use in hypertension and found it to have a marked hypotensive action".

"Even in the currently popular field of the chemotherapy of tuberculosis, indigenous plants are proving of interest. Thus, Japanese workers have isolated from a vine named *Stephania cepharantha*, and from a wisteria-like plant named *S. sasakii*, the alkaloid *cepharanthine* which is being used for the treatment and the prophylaxis of tuberculosis in Japan (*Jap. J. Exp. Med.*, 1949, 20, 69). Chinese workers have been investigating the anti-tuberculous activity of a series of local plants, and Virginia Wang (*Chinese Med. J.*, 1950, 68, 169) reports a 'prominent tuberculostatic activity' in extracts of *Coptis* root (*Coptis chinensis*) this activity apparently residing in its alkaloid, berberine sulphate. It is clear that much remains to be learned from a close study of indigenous herbs. It may well be that here lies one of the major contributions that countries such as China, India and Pakistan can make to the advancement of world health. Certainly this tendency should be encouraged by their colleagues in the West. We in the West have learned much from the old cultures of the East. May it not be that the East can contribute much of value in yet another field—that of therapeutics?"

Since the discovery of ephedrine from the Chinese drug, Ma Huang, Chinese materia medica have attracted considerable attention of many Western research workers, as also by Chinese workers in the same way that indigenous drug research is being conducted in this country. Two schools of study exist in Peiping and Shanghai which were engaged in the scientific appraisal of the claims of

numerous Chinese indigenous drugs. According to Tonkin and Work¹ a drug known as 'Chang shan has been proved to be an antimalarial more or less of the same potency as quinine. During the Second World War when China was almost completely cut off from the rest of the world, this drug was reported to have been used with considerable success.

The fruits of the closely related plant of *Ammi visnaga*, *Ammi majus* have long been used by the Egyptians for the treatment of leucoderma. Research work has also confirmed that this condition can be cured by the oral administration of an extract made from this drug and subsequent exposure to sunlight of the white patches on the skin. A crystalline active principle, ammoidin has also been isolated.

Rutin, now a well-known glycoside, originally derived from *Ruta graveolens*, has been reported from 40 different species of plants, including buck wheat, tobacco, elder and forsythia. Until 1942, it was a laboratory curiosity but now it is coming to be increasingly employed in the treatment of capillary fragility. Recently, an accidental discovery by a group of Pharmacologists has lead to what may be an important use of rutin in the treatment of the after effects of exposure to atomic radiation². Many more such examples can be cited.

Synthetic processes for which a chemist requires enormously high degrees of heat and pressure are being quietly carried by nature in plants at ordinary conditions of temperature and pressure. Chemists synthesised such alkaloids as quinine after intensive work extending over half a century whereas cinchona plant does this without difficulty everyday. Many active antibiotics occur in plants and this is yet an unexploited field. In fact we are only at the threshold of work of plant analysis and research. What is in store, no body but Nature alone knows. The research on these drug should therefore, for these reasons, go on for the good of the humanity. Even in Great Britain, Switzerland and the United States of America an intensive study of Indian indigenous drugs has been taken up in various research centres.

RE-INVESTIGATION OF KNOWN INDIGENOUS DRUGS.—Another aspect of this work is re-investigation of well-known vegetable drugs. Although some of these drugs have been known for many years, the last word has not yet been said about them. Podophyllum and its resin have long been known to cause irritation of mucous membranes and even skin. It is probably knowledge of this fact which initiated the use of podophyllum resin to destroy soft warts or condylomatas. Successful results were obtained by the local application of 25 per cent. suspension of the resin in mineral oil to venereal warts. This work was done with the American *Podophyllum peltatum*, but Indian podophyllum, *P. hexandrum* has even larger quantities of resin and podophyllotoxin, but the presence of α - and β -peltatins has not yet been confirmed³.

¹Tonkin and Work, 'A New Antimalarial Drug', *Nature*, Lond., 1945, 156, 630.

²Knowlton, et al., *Jour. Am. Med. Assoc.*, 1949, 141, 239.

³Mukerji, B., 'Indigenous Drugs Research—Present and Future, *I.C.M.R.*, 1953.

"Dutch workers have recently reported the beneficial effects of extract of liquorice for gastric ulcers; they also noted that about 20 per cent. of the patients developed cardiac asthma during treatment. Further investigation showed that the extracts have an action by mouth similar to that of injections of deoxycortone, causing sodium retention and potassium loss and they report beneficial effect of the treatment in Addison's disease. One of the components of liquorice is glycerhetic acid which is a polyterpene whose structural formula shows a striking resemblance to the Cyclopentano-phenanthrene steroids."

"Another interesting development in the recent study of *Digitalis* is the emphasis on its 'cardiotonic' rather than on its 'cardiotoxic' properties and the reported discovery of a new glycoside 'digicorin'. This glycoside, which has low toxicity, is claimed to possess the curative action of digitalis as distinct from that of the better known glycosides which are largely cardiotoxic. It can be extracted from the leaves of *D. purpurea* and *D. lanata*".

"Recent work on the anthraquinone group of purgative drugs has drawn attention to the importance of the form in which the anthraquinones occur in the crude drugs. Satisfactory chemical and biological methods of assay which have been developed show that the anthracene derivatives are highly active as 'anthranol' glycosides, less active as free anthranols and much less active as free anthraquinones. Studies on these lines made on Senna, Rhubarb, Cascara and Aloes tend to clarify the exact nature of the active ingredients in these drugs. This will now enable preparations of potent and stable galenicals for therapy which were not possible before."

"Recent work on the American veratrum, *Veratrum viride*, has shown its usefulness for the treatment of hypertension and it is very probable that the European veratrum or White Hellebore has a similar action. The pharmacological and clinical evaluation of veratrum has been greatly hindered by the complex chemistry of the drug. Already 15 alkaloids have been reported and some work on these has been done. Further studies might throw more light on its nature and action."

"It is difficult to form an unprejudiced opinion of the favourable reports on the deodorising properties of chlorophyll derivatives because of commercial claims calling attention to this new miracle material from Nature's own storeroom. However, there is a remarkable unanimity in the conclusions reached by reliable research workers on the deodorising value of the chlorophyll derivatives and also on their healing effects in the treatment of war wounds."

Such is the trend of thought with regard to research on Indian indigenous drugs. A few examples given above show how the field for research in medicinal herbs is being more and more widened for the benefits of suffering humanity.

VI

Historical Survey of Research in Indigenous Drugs.—We have already traced the evolution of the indigenous drugs from the earliest Vedic times to the

advent of Western medicine in India. We will now glance for a moment into the ancient Sanskrit materia medica preceding the advent of Arabic medicine. Some old Sanskrit works dealing with the classification of vegetable drugs and the utilisation of their parts in medicine as practised by the Hindu physicians of 14 or 15 centuries ago provide a most interesting reading. In books like 'Kalpastanum' elaborate classifications of drugs and medicinal plants are given. Divisions are made under such headings as tuberous and bulbous roots, barks of root, barks of trees possessing peculiar smell, leaves, flowers, fruits, seeds, acrid and stringent vegetables, milky plants, those containing gums and resins, etc. In the same work the earliest references occur respecting botanical geography, the sites and climates of different plants, the soils and seasons for collecting medicinal plants, the duration of their efficiency, the method of storage and the weights and measures to be used in pharmacy. There is evidence to show that even in the early Buddhistic period, pharmaceutical gardens were established for growing drugs and herbs for supply to the physician. Elaborate directions are to be found regarding the manipulation of drugs, some of them by no means unworthy of methods in use at the present time. Detailed instructions are given on every conceivable point, such as the gathering time, parts to be collected, making of preparations from them, etc. Annual plants were to be collected before the ripening of the seeds, biennials in the spring and perennials in the autumn; twigs were to be of first year's growth; the roots to be collected in the cold season, the leaves in the hot season, the barks and woods in the rains. No fewer than 26 different forms of preparations have been described including decoctions and infusions in water and milk, syrups, expressions, distillations, powders, extracts medicated oils and fermentation products. While the knowledge of ancient Hindu physicians of medicinal herbs was very vast and their vegetable materia medica was extensive, it is curious to note that, though undoubtedly they had picked up many herbs growing in the mountains and in the plains having remarkably potent active principles, some of the plants, quite as active, growing side by side with the others, were left untouched. Such for example has been the case with belladonna, ephedra, artemisia, etc., all of which grow in abundance in many parts of the Himalayas and yet no notice was taken of them. Some of these very drugs were utilised by the Chinese and Arabian medical men of the corresponding periods with success. The reason for this is very difficult to understand. After the period of decay had set in, very little interest centred in the new drugs. The knowledge contained in Ayurveda and other similar books began to be considered inspired and incapable of improvement by the ingenuity of man. The result was that not only did the existing knowledge remain at a standstill for nearly fifteen centuries but much of what existed was gradually lost.

We have already referred to the high standard of medical knowledge of the Mohammedans in the eighth and ninth centuries of the Christian era. Adolf Fohn in his 'Zur Quellenkunde der Persischen Medizin' enumerates 400 Persian works, very few of which have been published, dealing entirely or partly with medical subjects. Two of these works 'Abu Mansur' Muwaffaq's, Materia

Medica composed in A.D. 950 and 'Dhakhira-i-khwarazmshahi', a system of medicine written in the twelfth century are well-known. In these books *materia medica* is divided into three parts, the first dealing with animal products, the second with simple vegetable drugs and the third with compound medicaments. In some of these works mention has been made of drugs which produce anaesthesia before operation. In 'Shah-nama' composed early in the eleventh century Caesarean section practised on Rudaba, the mother of Rustam, has been described in which wine was used to produce unconsciousness. The Arabian medicine thus brought with it a rich store of its own *materia medica* and its exponents paid little attention to the indigenous drug resources. With the advent of Western medicine the inquisitive mind of the Eastern scholars began to probe into the mysteries of the Indian medicinal plants.

The study of Indian indigenous drugs was first begun in the early part of the last century and it was then confined chiefly to the collection of available information about various medicinal plants. The earliest contributions were from the pen of Sir William Jones who wrote a memoir entitled 'Botanical Observations on Select Plants'. This was followed in 1810 by John Fleming's 'Catalogue of Indian Medicinal Plants and Drugs', Ainslies's 'Materia Medica of Hindoostan' in 1813, and Roxburgh's 'Flora Indica' in 1874. Wallich, Royle and later Mouat and Macnamara did much towards resolving the chaos which existed in the vast mass of botanical material in this country into some degree of scientific arrangement. This was followed in 1841 by O'Shaughnessy's 'The Bengal Dispensatory and Pharmacopœia' which was the first book of its kind which dealt exclusively with the properties and uses of the medicinal plants used in Bengal. In 1868 a 'Pharmacopœia of India' was published under the able editorship of Waring and it signalled a new epoch in establishing and recording the value of indigenous medicinal products. The more important drugs were officially recognised with a view to their eventual adoption in the British Pharmacopœia. As a large number of the drugs, especially those in local use, were not studied in this work, Mohideen Sheriff published his 'Supplement to the Pharmacopœia of India' in the following year which added considerably to the utility of Waring's work. 'Materia Medica of Madras' by the same author which was edited and published after his death by Hooper is another very useful work dealing with drugs growing in the Madras Presidency and in use there. U. C. Dutt's translation of Sanskrit *Materia Medica* brought into prominence the drugs used by the Hindu physicians, and Flückiger and Hanbury's *Pharmacographia* was another very valuable production which recorded important material relating to the medicinal products indigenous to India. The other works of comparatively recent date are Dymock's 'Vegetable Materia Medica of Western India', 1883, followed by the publication of that very comprehensive book on the Indian medicinal plants, the 'Pharmacographia Indica', in 1890-93 under the joint-editorship of Dymock, Warden and Hooper. It is a most careful and useful compilation containing a mass of information regarding the uses of the indigenous *materia medica* in the Eastern and Western medicine. The most elaborate work of all is 'A

Dictionary of the Economic Products of India' published in 1889-1904 by Sir George Watt, the Reporter on the Economic Products to the Government of India. This monumental work not only gives a summary of all the previous work on the medicinal plants but every page of it teems with information regarding the use of different barks, roots, flowers, leaves and woods for different medicinal purposes. Notes are added regarding the cultivation of various drugs; the economic importance of many of them with reference to their inland and export trade is also described. The quality of the drugs produced, the parts of the country to which they belong and even the results of their clinical trials by various medical authorities are meticulously recorded. Works published still later such as Kanai Lal Dey's 'Indigenous Drugs of India' and Kirtikar and Basu's 'Indian Medicinal Plants' are largely summaries and compilations from the above mentioned literature. In the latter work, plates illustrating various important medicinal herbs are given which greatly help the worker in differentiating them from plants with which they are apt to be confused.

Apart from the present volume another recent work on the subject is 'The Wealth of India' 1949-53, a very comprehensive treatise which is being published under the auspices of the Council of Scientific and Industrial Research. This book is really a new edition of A Dictionary of Economic Products of India, published in 1889-1904, brought up-to-date. It will be published in ten volumes or so. The first five are already out and do credit to the Editorial Board of the Council of Scientific and Industrial Research. In these books the results of investigations of many drugs on the lines indicated above are given. The research on Indian Indigenous Drugs, it will be seen has thus been put on sound scientific basis.

The literature mentioned above is very valuable, as it contains not only information from Ayurvedic and Tibbi courses, but also gives the results of personal observations and experiences of some of the writers. There is no doubt that a considerable amount of botanical investigation into the scientific names of drugs has been accomplished though more remains to be done in the case of some drugs to clear up many points with respect to their exact botanical sources. New drugs that have escaped the previous investigators require to be explored in all their details. Warden and Hooper carried out a very laborious study of the chemical composition of many of the important drugs. The Indigenous Drugs Committee did useful work and was responsible for obtaining authentic specimens of tried remedies, making standard preparations and encouraging their use in the various Government institutions throughout the country. Besides these efforts, many individual workers have from time to time taken up some drug and tried to establish its pharmacological action by modern methods of research, but these workers have been handicapped for want of properly equipped laboratories.

Admirable as all these attempts have been, yet the pharmacology of most of the indigenous remedies remained an unexplored field till recently. The reason of this was not far to seek. Investigations of this nature require a considerable outlay of money in the form of well-equipped chemical and pharmacological

laboratories, while a liberal staff of competent chemists and pharmacologists is another essential prerequisite. Medicine is now intimately related to chemistry, and the ultimate solution of most problems, whether physiological or biological, rests on some physical or chemical basis. This is forcibly presented to us in the study of the action of drugs. The importance of the co-operation of chemists at every stage of research work can only be realised by the workers themselves. If satisfactory results have to be achieved and if the work is to be carried out on the same standard as other civilised countries, the co-operation of competent chemists is essential. Besides this the time and labour required to work out the chemical composition of a single drug are enormous. This may be judged from the fact that it would take an experienced chemist several months, perhaps a year or more, to isolate in a pure state and roughly describe the nature of the different chemical constituents of a single crude drug. The determination of the chemical constitution of the active principles concerned would take a considerably longer time even if the chemist devoted his time entirely to one active principle. The isolation of a sufficient quantity of the active principles and the testing of them pharmacologically would occupy several months. The magnitude of the task of working out all the drugs used in the indigenous systems of medicine transcends all imagination. There is such an enormous field for research in this direction, and so little has been done, that it is impossible for any one individual or any one institution to cope with it adequately. The co-operation and intimate association of a large number of sincere and devoted workers of ability is needed to find the truth. Chairs in pharmacology should be founded by the various universities and medical colleges, and facilities given for research work.

The situation must however be faced. As the action of these drugs or their active principles can only be established by a careful chemical, pharmacological and clinical study, the investigation in all the three aspects should be carried on side by side. The experimental work on the pharmacological side can be done only in laboratories well equipped with all modern appliances. None existed in this country to enable one to do the work on scientific lines till the Calcutta School of Tropical Medicine was established in 1921, one of the main duties of the Professor of Pharmacology being investigation of the indigenous drugs on scientific lines. The chemical department of this institution had a team of experienced chemists who worked out the chemical composition of drugs, isolated the active principles, and handed them to the pharmacologist for determination of their action on the animal organism. The clinical testing of the drug was made possible by the Carmichael Hospital for Tropical Diseases, a research hospital attached to this institution. In this way it was found possible to go through a number of drugs in all the varied phases of their investigation, i.e., from the isolation of their active principles to the testing of their action on animals and finally to the making of suitable preparations for trial on patients, and for recording the results of therapeutic trials.

During the three decades that have followed, the research work on indigenous drugs has received considerable encouragement and has made satisfactory

progress. Such semi-Governmental organisations as the Indian Council of Medical Research, the Indian Council of Agricultural Research and last but not the least the Council of Scientific and Industrial Research have given very generous grants to various Medical Institutions and other research bodies for this work. In fact the last named, the Council of Scientific and Industrial Research, established in 1950 the Central Drug Research Institute at Lucknow as one of the eleven major National Laboratories of India. One whole division of this great Institution is devoted entirely to the study of Indian Indigenous Drugs. With the dawn of Independence, therefore, this research has been put on a sound and firm basis.

VII

Three Main Aspects of the Problem.—After a careful survey of the Indian medicinal plants three aspects of the problem forcibly presented themselves from scientific as well as economic points of view. The research work on indigenous drugs initiated by the senior author at the Calcutta School of Tropical Medicine was undertaken with three main objects in view:

(1) To make India self-supporting by enabling her to utilise the drugs produced in the country, and by manufacturing them in forms suitable for administration.

(2) To discover remedies from the claims of Ayurvedic, Tibbi and other indigenous sources suitable to be employed by the exponents of Western medicine.

(3) To discover the means of effecting economy, so that these remedies might fall within the means of the great masses in India whose economic condition is very low.

It is to the discussion of these three aspects which emerge from a study of the problem that the attention of the reader is invited in particular.

PHARMACOPOEIAL AND ALLIED DRUGS.—The first proposition is likely to lead to great results, because a large number of drugs which grow in this country are known both to Eastern and Western medicine and the properties and actions in many cases are also not unknown. The research here has been diverted into two main channels. Firstly, there are many drugs of established therapeutic value which are in use in the pharmacopoeias of different countries. The majority of these grow wild and in great abundance in many parts of India and a certain number are even cultivated. Some of these were collected and exported, though an infinitesimal fraction of the quantity produced, to foreign countries and came back to us in the form of standardised pharmaceutical preparations and active principles in pure condition, probably at a price many times of the original crude product. A host of others grew, matured and eventually died without being put to any practical use whatsoever. There are numerous examples which will be dealt with at length in the subsequent pages but a few will suffice to illustrate the possibilities of their development.

Atropa acuminata grows in great abundance in a state of nature in the Himalayan ranges from Simla to Kashmir at an altitude of 6,000 to 12,000 feet above the sea level. Large quantities of the root were collected and were exported to Europe and America. *Hyoscyamus niger* is a native of the temperate Himalayas at an altitude of 6,000 to 10,000 feet and a good quality of the drug can also be grown in the plains of the Punjab. A number of species of *Mentha*, *Aconite*, and *Juniper*, grow all over the Himalayas; *Juniperus communis* occurs abundantly in some part of Kashmir. *Valeriana wallichii* can be found in large quantities in Kashmir and Bhutan. A number of varieties of *Artemisia* grow in the northern Himalayas and the mountain ranges of the West Pakistan and santonin-bearing *Artemisia brevifolia* grows abundantly in Kashmir and the Kurrum valley. A very good quality of *Podophyllum emodi* is met with in the higher shady temperate forests of the Himalayas from Sikkim to Kashmir at a height of 7,000 to 9,000 feet.

Besides these there are a number of pharmacopoeial drugs which are widely used by the medical profession, but which do not naturally grow in this country. They thrive, however, when they are cultivated under proper conditions in suitable parts of the country. Examples of such drugs are numerous but a few of the important ones such as *Digitalis*, *Ipecacuanha*, *Eucalyptus*, *Cinchona*, *Jalap*, etc., may be cited. They were introduced into India many years ago and are doing well. On account of the great demand for these drugs their production in this country would be of some economic importance, especially in view of the gradual extension of Western medicine among the masses. India possesses most wonderful variability so far as the temperature and general climatic conditions are concerned and as will be shown later every conceivable drug ranging from those growing in the hottest tropical and damp climates to those growing in dry, temperate and very cold climates can be grown and acclimatised in some part or other. From the geological point of view also every grade of soil from alluvial deposits to hard rocky formation and sandy deserts is met with. Professor Greenish of the London School of Pharmacy rightly said, "India, owing to the remarkable variations she possesses of climate, altitude and soil, is in a position to produce successfully every variety of medicinal herb required by Europe".

It should be remembered, however, that the soil, the season and the gathering time are some of the important variable factors with plants and it can hardly be expected that the amount of active constituents would be constant under all conditions. In some cases the quality is good and constant, but in many instances the percentage composition of the active principles has yet to be determined by careful methods of chemical and biological assay, to show that these remedies, growing in a state of nature, are as good in quality as those of the imported varieties. If they do not come up to the required standard, the best method of bringing them into general use by improving the quality of the active principles by suitable cultivation, in parts of the country where this can be done economically, has yet to be determined.

Secondly, a large number of plants grow in India which, though not exactly the same, possess properties and actions similar to the imported and often expensive remedies, and would form excellent substitutes. Not infrequently it is some closely-allied species which is pharmacologically just as active. That many such plants do exist, there is very little doubt; but since no effort has been made to work out their medicinal properties on scientific lines, or to confirm the work already done, there appears to be a great deal of uncertainty about their action. Unless such work is done it can hardly be expected that they will be taken into use by the profession, in the place of more certain and tried remedies. Numerous examples come to one's mind but a few may be cited. *Colchicum luteum*, grows on the slopes of the western temperate Himalayas and would form an excellent substitute for the official *C. autumnale*. *Scilla indica* grows extensively on the seacoast and on the drier hills of the lower Himalayas and the Salt Range and would make a good substitute for *S. maritima*. *Ferula narthex* from which a gum resin resembling asafoetida can be obtained, grows in Kashmir. The properties of *Picrasma quassioides* and *Gentiana kurroo* resemble those of *Picrasma excelsa* and *Gentiana lutea* respectively of the British Pharmacopoeia.

More examples may be cited of substitutes. Such drugs are being investigated, their active principles are being worked out, their percentage composition is being determined, their action established and standardised and pharmaceutical preparations are being manufactured much to the economic benefit of the country.

VIII

India's Foreign Trade in Drugs.—The economic importance of the first proposition can only be fully appreciated by studying the position of the drug trade of India. A study of the figures of the total values of imports and exports during the first three or four decades of this century discloses that both the imports and exports of drugs steadily increased. Thus in the year 1908-09 the value of the drugs exported from India amounted to Rs. 15.5 lakhs against imports which amounted to Rs. 73.0 lakhs. In the year 1928-29 the export and import values of drugs were respectively 42 lakhs and 200 lakhs. This shows the remarkable extent to which the trade increased and at first sight this would appear to be a very satisfactory state of affairs. A closer scrutiny, however revealed that the imports are proportionately very much larger than the exports. This meant that while much raw material was going out of the country, very considerable quantities of refined preparations manufactured in foreign countries were coming into the Indian market. The position was not improving although the averages of imports and exports for the pre-World War I, World War I, and post-World War I periods and another period of five years from 1924-25 to 1928-29 show a slight fall in imports and some rise in exports.

TABLE I

		Value of Imports Rs.	Value of Exports Rs.
Pre-World War I: average	....	94,10,289	18,17,835
World War I: average	....	127,85,189	29,54,350
Post-World War I: average	....	179,91,326	36,15,878
Average of 5 years (1924-25 to 1928-29)	....	166,40,196	37,19,870

If we now proceed a little further into details and carefully study the reason of the large excess of import over export it is obvious that most of the imported drugs were standardised pharmacopoeial preparations such as purified alkaloids, in many cases manufactured from the same drugs that were exported; besides these there was a large import of proprietary or patent preparations. A perusal of the Table II shows that over 100.9 lakhs worth of the former group under the heading of 'other sorts of drugs and medicines' and 42.8 lakhs worth of the proprietary preparations were imported in 1928-29. The proprietary and patent medicines exhibited a phenomenal increase during the five years, i.e., from about 25.0 lakhs to 42.8 lakhs. This showed the increasing extent to which the Indian market was being exploited by the manufacturers of these remedies. The figures showing pharmacopoeial preparations and chemicals rose from 87.8 lakhs to 114.3 lakhs in 1927-28 but showed a slight decrease to 100.9 lakhs in 1928-29. The import drug trade, taken all round, showed a definite and marked increase. The other items of interest in this table are camphor, whose import was steadily on the increase, and the quinine salts, which showed some fluctuation but on the whole showed an appreciable increase.

The most outstanding figures in the export Table III are those under the heading 'total drugs and medicines' which show a persistent increase from 35.8 lakhs to 41.6 lakhs during the five years. This would appear to be promising but for the much larger increase in value of prepared drugs imported. A list of different drugs exported under the heads of 'other sorts of drugs and medicines', spices, oil seeds, narcotics, etc., in the Seaborne Trade Returns of India is given below. The list does not pretend to be exhaustive but furnishes only the most important drugs included under these groups.

Aconitum napellus, *Alstonia scholaris*, *Atropa belladonna*, *Althæa officinalis*, *Arachis hypogæa*, *Areca catechu*, *Anogeissus latifolia*, *Berberis aristata*, *Butea frondosa*, *Catechu nigrum*, *Swertia chirata*, *Cannabis indica*, *Cocculus indicus*, *Cambogia indica*, *Croton tiglium*, *Cuminum fructus*, *Cæsalpinia bonducella*, *Cassia fistula*, *Ephedra vulgaris*, *Datura fastuosa*, *Hemidesmus indica*, *Ipomœa hederacea*, *Terminalia chebula*, *Podophyllum indica*, *Papaver somniferum*, *Piper longum*, *Piper nigrum*, *Picrorhiza kurroo*, *Ricinus communis*, *Saussurea lappa*, *Santalum album*, *Urginea indica*, *Zingiber officinale*.

TABLE II
Drugs and Medicines (Excluding Chemicals and Narcotics) Imported into India during Five Years from 1924-25 to 1928-29

Drugs Imported	QUANTITY					VALUE IN RUPEES				
	1924-25	1925-26	1926-27	1927-28	1928-29	1924-25	1925-26	1926-27	1927-28	1928-29
										Included in drugs of other sorts.
Aloes—cwt.	1,961	547	2,375	1,004	—	37,218	12,394	67,792	25,543	—
Asafoetida—cwt.	6,335	2,719	3,947	3,236	3,612	3,77,005	1,86,642	1,57,412	1,14,532	208,343
Camphor—lb.	2,07,150	9,93,007	14,01,695	13,73,701	16,12,356	23,02,563	21,47,341	27,06,850	25,93,177	27,79,631
Cocaine—oz.	747	1,334	551	1,157	1,259	11,082	20,737	11,636	17,622	18,476
Cod liver oil—lb.	—	84,82	66,857	75,638	90,602	—	1,50,097	1,22,733	99,435	1,30,796
Morphia and preparations of opium—oz.	640	687	1,090	1,111	1,800	47,447	64,312	1,05,262	1,34,919	1,36,564
Quinine and salts—lb.	1,07,523	1,30,459	1,19,567	1,13,637	1,33,795	28,08,734	30,96,160	26,25,239	23,42,186	24,47,075
Sarsaparilla and preparations	—	—	—	—	—	40,650	43,185	24,321	37,307	—
Storax	1,11,762	1,30,753	94,455	1,10,899	—	31,566	34,297	28,974	29,775	—
Saccharine	—	—	—	—	29,612	—	—	—	—	1,12,652
Proprietary and patent medicines	—	—	—	—	—	25,06,303	24,15,232	27,20,228	29,26,782	42,83,667
Other sorts of drugs and medicines	—	—	—	—	—	87,88,830	91,30,150	103,03,590	114,38,753	100,95,756
Total	—	—	—	—	—	166,64,005	173,11,020	190,02,128	198,28,068	202,12,950

N.B.—1 lakh=1,00,000.

INDIGENOUS DRUGS OF INDIA

TABLE III

Drugs and Medicines (Excluding Chemicals and Narcotics) Exported from India during Five Years from 1924-25 to 1928-29

Drugs Exported	QUANTITY					VALUE IN RUPEES				
	1924-25	1925-26	1926-27	1927-28	1928-29	1924-25	1925-26	1926-27	1927-28	1928-29
Asafoetida—cwt.	9	54	65	—	—	1,783	2,953	4,219	735	—
Camphor—lb.	1,382	16	—	100	—	1,425	80	—	175	—
Cinchona bark—lb.	5,59,592	4,86,187	80,691	1,73,529	1,38,104	2,12,712	2,45,398	43,460	90,002	78,024
Galangal—cwt.	188	519	536	633	575	5,157	12,662	11,915	14,096	12,850
Nux vomica—cwt.	30,258	44,079	54,347	50,702	43,212	2,27,836	2,96,091	3,48,653	3,27,858	3,03,208
Senna—cwt.	47,544	44,995	49,117	52,814	46,995	10,71,678	8,93,052	8,93,052	9,48,812	8,60,208
Other sorts of drugs	—	—	—	—	—	19,83,384	2,22,711	24,03,426	20,11,689	29,06,142
Total drugs and medicines	—	—	—	—	—	35,87,425	36,77,347	37,10,220	34,53,367	41,60,988
Tea dust for manufacture of caffeine—lb.	32,39,907	30,00,969	15,91,330	41,14,638	—	4,90,644	5,50,983	2,63,810	4,41,671	—

N.B.—1 lakh=1,00,000.

It will be seen from the list given above that all these drugs in crude forms were annually exported from India to foreign countries at a nominal price, were utilised in various medical and allied industries and a portion of them, at any rate, returned to India in the form of expensive preparations. The finished products naturally fetched considerably higher prices and hence the increase in the export revenues only shows to what an extent the Indian raw materials were being utilised by the drug manufacturers of other countries to their benefit and the economic loss of India.

IX

Drugs Used in the Indigenous Medicine.—The second proposition of popularising and introducing new drugs to Western medicine is a more difficult one. Since the period of decay and recompilation, many of the effective remedies have been lost and a number of uncertain ones have come in. The result is that in the indigenous systems at the present time almost every plant and shrub growing in the country has ascribed to it some medicinal virtue. These beliefs, in some cases, originate from the teachings of the ancient commentators and are based on clinical data, but in others have no foundation whatever. Their introduction was empirical and often a drug was used simply because a single case happened to have derived some benefit from it. In this way remedies have multiplied without proof but by belief, and, as they hail from all parts of India, no one seems to have a correct notion about their uses and properties. The employment of a large number of them would thus appear, as in Western medicine, to have been based on empirical evidence handed down from generation to generation. A thorough and complete research into all these drugs would constitute the lifelong work of innumerable chemists, pharmacologists, and physicians. For practical purposes the method adopted has been to make use of the experience of Kavirajes, Hakims and others, and to take up those drugs which have a great local reputation for investigation before touching the less reputed remedies. Besides, many of these drugs have been clinically tried by some of the medical men practising Western medicine, who have expressed their opinion regarding their efficacy; this has also been helpful in the selection of drugs to be investigated.

Not infrequently, clinical trials are carried by workers themselves before taking up investigation of a drug on scientific lines. A large number of drugs are referred to by medical practitioners and others for opinion and often requests are made that, as the particular drug sent is useful, its investigation may be taken up at once. To avoid wasting time and money, it is tried on a series of cases carefully following the instructions given. If the results obtained after such trials are satisfactory the drug is handed over to the chemists for analysis; if not, it is discarded.

IDENTIFICATION OF INDIGENOUS HERBS.—The drugs are many in number and varied in character, and the process of inquiry is long, tedious and laborious. In addition to these there are other difficulties which confront the investigator and

have to be surmounted. Many of the remedies mentioned in the old books baffle and defy recognition and identification, and one cannot be certain from the description whether the specimens obtained are of the particular drug described.

The identification of drugs will remain a prime difficulty until certain prominent characteristics of each drug become established. No amount of verbal description of these drugs as given in the books will enable the botanists to identify some plants and parts which even in themselves do not invariably present the same characteristics. The result is that there has been a good deal of confusion; many drugs are being sold under various names, different drugs under the same name, and even the learned Kavirajes and Hakims cannot say with certainty which is the authentic specimen meant in the old texts. We have often come across entirely different herbs being sold in different States under exactly the same name. A very careful enquiry has often to be made in which considerable help can be obtained from the local names given to the herbs. There are professional castes who deal with the medicinal herbs, who have considerable knowledge of these plants, and who can throw much light where all other measures fail. In Central and Upper India *Musheras*, in Bengal people of such low castes as *Maules*, *Bediyas*, *Bagdis*, *Kaibartas*, *Pods*, *Chandals*, *Kaoras*, and *Karangas* and on the Bombay side *Chandras*, *Bhils* and *Gamtas*, know a great deal about the herbs used in indigenous medicine and described in old books.

ADULTERATION OF DRUGS.—From very early times adulteration of drugs was very severely dealt with in India. In the Buddhistic period anti-adulteration laws were drawn up on the lines of strictest severity and even the slightest carelessness on the part of the physician was vigorously dealt with. The dictum laid down was that 'all physicians who treat their patients wrongly shall pay a fine'. Unfortunately things were changed considerably with the decline of the Ayurvedic medicine. Partly on account of ignorance and partly because of deliberate intention on the part of dealers, adulteration of drugs has been practised for many centuries. Adulteration and substitution of one drug for another was so rife in the case of the indigenous drugs that the faith of the people of India became weakened in the products of their own country. Outside India, drugs of Indian origin are generally regarded with suspicion and considered worthless and unreliable on this score alone. *Cannabis indica* has lost a considerable portion of the reputation it once had in European practice on account of the fact that it is not of the same standard of quality as it was in former years. Similarly, the bark of *Holarrhena antidysenterica* (Kurchi) lost its undoubted position as a specific in dysentery through the substitution of worthless barks; the aconites were equally unreliable. Even in the domain of the finished products considerable adulteration occurs. Nostrums and quackery are rampant to such an extent that people are duped every day. Many of the tinctures and spirits are below strength and this factor has brought the Indian manufacturers to a very low position and has had a damaging effect on India's export trade. The evidence before the Drugs Enquiry Committee (1930-31) left no room for doubt that, in regard to adulteration,

deterioration or tampering with the quality or strength of drugs, very little distinction could be made between imported and locally manufactured medicinal preparations. This evidence was not only from medical men who tried the drugs clinically but was also based on actual analysis of the drugs by such highly placed authorities as Chemical Examiners, Public Analysts, Officers in charge of Custom and Excise Laboratories, etc. Having regard to the seriousness and far-reaching character of the problem the Committee also collected a large number of samples of drugs at random from the different provinces of India and subjected them to a careful analysis under the supervision of experts. The results confirmed the views of the witnesses in all their different aspects and reinforced the impressions generally prevalent. Not only is there adulteration, but many of the firms sell packages which are considerably underweight. The traffic in such drugs is extensive and indiscriminate. Unless and until this practice of adulteration and substitution is stopped the trade in Indian drugs and the preparations made from them will not improve in and outside India, and the use of indigenous products in the treatment of diseases will not be successful. The fact, though well-known, should be emphasised that economy cannot succeed at the cost of efficiency.

DRUGS USED IN INDIGENOUS SYSTEMS.—Hakims, Vaidyas and some of the firms manufacturing medicinal preparations mainly depend for the supply of the crude drugs on ordinary drug dealers (Pansaries) in the Bazar. While giving evidence before the Committee on Indigenous Systems of Medicine (1948), eminent practitioners of these systems complained that they found great difficulty in obtaining genuine drugs. The great majority of these available in the market are invariably either heavily adulterated or entirely replaced by cheap and worthless substitutes dressed up to resemble the genuine article. All the witnesses and, particularly the leading manufacturing firms dealing with these drugs have expressed great dissatisfaction and have pressed for early action to rectify this state of affairs. They expressed the opinion that on account of difficulties involved in proper identification of medicinal plants, it is difficult to get even genuine specimens of commonly used drugs in the market.

In the course of time more and more drugs of vegetable origin were included in the indigenous materia medica and at the present time about 2,000 such drugs with alleged medicinal properties have been enlisted. No precise descriptions regarding their identification have even been recorded. There are of course some vague descriptions of plants but these are confusing and definite characters for identification are not available. Further, the science of pharmacognosy of the plants as known to Western medicine now, was unknown. As a result of these vague and confusing descriptions some of the important drugs of Ayurveda are not traceable at all as for instance, Ashtwarg (a group of eight plants which are considered to be very efficacious) are very difficult to trace at present. The drugs of indigenous medicine are not only without any definite botanical descriptions, but there are also no chemical or biological standards laid down anywhere to

evaluate the quality of the crude material or the finished product prepared from them as is done in the pharmacopoeias of Western medicine. The only tests applied are colour, smell, hardness, etc., of the crude material.

Since there is no proper Pharmacopoeia in the modern sense in the Ayurvedic or Unani systems where standards are laid to judge the quality of drugs and since there is no Government control over the sale of such adulterated and spurious drugs, the drug dealers (Pansaries) take full advantage of this and sell to their customers anything that resembles or may be made to resemble the genuine drug. The Pansaries have become such adepts in the art of the adulteration and preparation of spurious drugs that often even the learned Vaidyas find it difficult or even impossible to distinguish between genuine and spurious samples. It would not be an exaggeration to say that there is at present hardly any drug for which a spurious substitute is not available in the market and of course at a comparatively much cheaper price.

This is quite evident from a survey of about twenty commonly used drugs collected in the markets all over India by Handa, *et al* (*Indian Journal of Pharmacy*, Vol. VIII, No. 2, 1951). Practically all of them were highly adulterated. Drug legislation which has been enacted during recent years has done much to improve the quality of drugs and medicinal preparations of the Western medicine on the market in India. Unfortunately for reasons stated above and for want of any definite standards for comparison it has not been possible to enact any legislation to control the spurious and below standard drugs used in the Indigenous Systems of medicine both Ayurvedic and Unani.

X

How to Effect Economy and Bring the Treatment Within the Means of the Masses.—The third proposition relates to the devising of expedients for effecting economy, so that these remedies may reach the masses. This is only possible if the price of the drugs can be considerably reduced; for, in a poor country like India, there are millions of people who cannot afford any kind of treatment, whether cheap or expensive, and have consequently to depend upon charitable medical relief institutions. The cost of drugs is so heavy that most of these institutions, which have only a limited annual budget for drugs, are not able to cope with the demand for such common and essential drugs as quinine, castor oil, magnesia, etc., to say nothing of the expensive medicines which are necessary and even indispensable.

The only way in which drugs can be cheapened and brought within the means of the masses is to utilise the local resources and substitute the indigenous products for the more expensive imported preparations of Western medicine. This can be done by encouraging the production, collection and manufacture of the local *materia medica* by preparing pharmaceutical preparations in a systematic manner. By local production and substitution of equally potent drugs of Indian origin for the imported drugs, the cost of treatment can be considerably reduced. We have

already made reference to these remedies and the possibilities of their development. Their active principles can be isolated, and standardised preparations such as tinctures, extracts, powders, etc., can be prepared without difficulty with inexpensive apparatus. If this is done on a large scale, it will be possible not only to effect saving in the seaborne freight but in many other charges.

During recent years considerable progress has been made in the direction of manufacture of pharmacopoeial preparations and refined chemicals for medicinal purposes from the crude products of this country. It will be appropriate here to take stock of the present position with regard to the drugs and pharmaceutical industry in the country and the import of finished products from abroad. It may be stated at once that the World War II gave a great impetus to the drugs and pharmaceutical industry in India. Owing to great home-demand for civil and defence purposes and also on account of shipping difficulties, the import from foreign countries of medicinal preparations into India was very greatly curtailed. The Government of India, therefore, encouraged the manufacture of as many medicinal preparations and by-products of drug manufacture in the country as could be accomplished. This was done primarily to meet the demand from the Defence Forces but the civil population also benefited. The result was that many Industries started during the World War II came to stay and after the war ended and even have expanded their activities. Many new ventures were started and have flourished. All this has led to the present improved condition of the drug industry.

Dr. B. Mukerji, Director of Central Drug Research Institute, Lucknow, at the instance of Pharmaceutical and Drugs Committee of the Council of Scientific and Industrial Research has lately collected statistics of the capacity and production of certain lines of pharmaceutical manufacture in India, as well as import of medicinal preparations from foreign countries. In the following statement the capacity and production of certain lines of pharmaceutical manufacture is given. The figures are far from being accurate but give some idea as to extent of production of various products in India:—

Statement Showing Capacity and Production in Certain Lines of Pharmaceutical Manufactures

<i>Galenicals:</i>	Capacity about 12,00,000 gallons per year. Self-sufficient and surplus for export.
<i>Tablets:</i>	Capacity 1056 million tablets per year. Sufficient for present demands.
<i>Proprietarys:</i>	Can meet entire demands in respect of cough remedies, poultices, antacid products, tonics, haematinic preparations, vitamin-containing products, enzymic preparations, etc.
<i>Injections:</i>	Glucose, normal saline, distilled water, calcium gluconate, quinine bihydrochloride, emetine hydrochloride, vitamins,

liver extracts, etc. are being manufactured with a capacity of 109 million ampoules per year, which is sufficient for needs.

Alkaloids, etc.:

Ephedrine, caffeine, atropine, strychnine, quinine, opium, kurchi alkaloids, santonin, and emetine are being manufactured. About 75 per cent. of the B.P. alkaloids can be produced from plants grown in India.

Caffeine: installed capacity	....	20,000	lb. per year
Strychnine	....	15,000	" " "
Quinine	....	1,00,000	" " "
Opium derivatives	....	8,000	" " "

Emetine is the only alkaloid for which raw material has still to be imported almost entirely.

Biologicals:

Capacity of private industry	... 60	million c.c. per year
Government: capacity	... 96	" " " "

Liquor adrenaline hydrochloride:

capacity	....	40	" " " "
Liquor adrenaline tartrate	....	44	" " " "
Liver extracts: capacity (oral)	....	1.4	" lb. " "
Injectules	....	23.8	" c.c. " "

Vitamin A:

Shark liver oil: capacity 5,50,000 million I. U. " "

Fermentation products and derivatives:

Calcium lactate, malt extract, chloroform, ether, ethyl chloride, chloral hydrate: Production generally meets the demand.

Inorganic drugs:

Sufficient quantities of magnesium sulphate, magnesium carbonate, magnesium oxide, phosphoric acid, phosphorous, sodium chloride, ammonium chloride, potassium bromide, potassium permanganate, potassium bicarbonate; potassium, sodium and iron citrates; sodium and potassium acetates.

A study of the figures given shows that the production of pharmaceuticals, galenicals, etc., is satisfactory. In many of the items not only is the country producing sufficient for its own needs but there is surplus for export also. There is unfortunately deficiency in the field of antimalarial and sulpha drugs, and antibiotics. Below are given figures of the value of imports from foreign countries of drugs and medicinal preparations for the past three years:—

Total drugs and medicines	1949-50	1950-51	1951-52
....	Rs. 7,85,96,133	Rs. 9,93,55,736	Rs. 15,15,15,102

By far the largest imports are from the United Kingdom and next comes the United States of America; the imports from other countries are comparatively small. It will be seen that imports are rapidly on the increase. The main items here are antibiotics, sulpha drugs, antimalarial and proprietary preparations which account for the major part of this increase. It is thus obvious that there is need for intensive research in the field of new drugs, particularly antibiotics possibly

from soil micro-organisms of this country. There is still considerable drain of Indian money into the foreign countries which should be prevented by the development of our own resources and making the country self-sufficient. It is satisfactory to note that a penicillin factory is already in the process of being established near Poona with the help of UNICEF and WHO. There is no doubt that along with it other antibiotics will also be manufactured and the local sources of new antibiotics will be investigated.

The two large fields in which progress is to be made are, (a) Synthetic drugs, and (b) Antibiotic drugs:

(a) *Synthetic Drugs*.—Sulpha drugs are being manufactured in India: Sulphathiazole 4,00,000 lb., sulphapyridine more than 50,000 lb. and sulphadiazine 2,00,000 lb. These are sufficient for the requirements of the country at present. The production of isonicotinic acid hydrazide has been started. Para-amino salicylic acid is also being manufactured. These two drugs are useful in the treatment of tuberculosis. Nikethamide is being manufactured. Besides the following drugs are being produced: calcium gluconate, calcium glucono-galacto gluconate, sulphacetamide, diiodohydroxy quinoline, iodohydroxy quinoline sulphonic acid, bromo-iso-valeryl urea, cinchophen diamino diphenyl sulphone and its salts, diphenylhydantoin, antimony gluconate, carbarsone, sulpharsphenamine, urea stibamine, p-d-acetyl aminobenzaldehyde thiosemicarbazone, nicotinic acid, nicotinamide. Of the antiamoebic drugs, iodochlorohydroxy quinoline is being manufactured. Very few of the synthetic antimalarials are yet in production.

(b) *Antibiotic Drugs*.—So far as the group of antibiotics is concerned, the country's annual requirements at present are, penicillin about 10 million mega units, streptomycin about 7 million grammes, chloromycetin about 2 million grammes and aureomycin about 2,00,000 grammes. These are at present imported into India in bulk and are being bottled in the country. On account of intricate processes involved these are not yet manufactured in the country. A penicillin factory is being started by the Government with an output of 3.6 million mega units which will be raised to 9 million mega units in due course. Manufacture of streptomycin and chloromycetin will soon be taken up by private enterprise.

In regard to the development of the manufacture of coal-tar intermediates, it may be stated that these are required for the dye-stuffs, and fine chemicals and plastic industries. These industries have not so far developed in the country and demand for them is very small. While these industries are coming up and demand for coal-tar intermediates is being created it is necessary to find out the required raw materials. Benzene is one of the main raw materials and we have a potential source of its supply in the coke-oven gas, from which benzol (crude benzene) can be recovered. From the existing coke ovens about 5 million gallons of benzol can be recovered every year but the present capacity is only 1.824 million gallons. It is desirable that till such time as sizeable quantities of benzol are required for the manufacture of coal-tar intermediates, arrangements should be made to recover

it to the full extent possible for use as motor fuel in admixture with petrol (where upto 20 per cent. of it can be used).

PROPRIETARY MEDICINES.—The problem of effecting economy might also be tackled from another side, that is by avoiding as far as possible the use of proprietary and patent medicines. A perusal of the tables will show that drugs belonging to this class are being annually imported into the country in increasing quantities. The tendency on the part of the medical profession in India to use proprietary drugs in preference to the pharmacopoeial drugs is to be greatly deplored. It is a painful thing to see that almost every prescription sent to the dispensing chemists contains some proprietary medicine or other. These of course greatly increase the expense to the patient and this fact unfortunately is not often realised by the practitioners. We have always held that if the combined drugs of the British and United States Pharmacopoeias are not going to give relief to the patient, proprietary remedies, the composition and action of which are in many cases unknown will certainly not improve matters. While it cannot be denied that some of the proprietary remedies are very effective therapeutic agents, a large number of them have not even the efficiency of cheaper and more easily available drugs, and some have been proved to be not only entirely useless but even harmful. This widespread use of proprietary medicines cannot be attributed to anything but lack of interest on the part of medical practitioners in the science of pharmacology. If they paid a little more attention to the rational rather than empirical use of drugs, they would not be so easily deceived. They would not be so ready to believe the preposterous claims put forward in the drug notices and circulars sent to them by the manufacturers who advertise on a lavish scale, putting forward claims which cannot be substantiated, not only in the lay papers but also in some of the medical journals in this country. It is a matter for deep regret that medical journals should lend themselves to the publication of such notices.

XI

Use of Crude Drugs.—By using crude drugs and preparations the cost of treatment could be considerably reduced. The utility of the Western medicine to the masses in India has been limited by reason of its costliness. Its further progress, in spite of all efforts that are being made, is being hampered for economic reasons; because of the poor returns of agriculture and the small wage-earning capacity of the people, they can afford only the cheapest remedies and treatment. So long as the economic conditions of India remain as they are at the present time, the average villager demands, and very naturally so, something within his means, i.e., medical advice costing a few annas and the treatment costing even less. The separation and purification of the active principles from drugs or making standardised preparations naturally involve considerable additional expense. The result is that a bottle of medicine lasting only a few days costs twelve annas to two rupees which is far beyond the means of an average Indian. A great many of the maladies of everyday life for which drugs are used are of a minor nature. Many of the crude drugs available in the bazars, if intelligently used, are very

nearly as efficacious as the refined preparations, and substitution of such cheap products is bound to bring down the cost of treatment to a minimum. Crude vegetable purgatives are often as effective as the elaborated products. Economy can also be effected in many of the most widely-used drugs in this country and many examples can be cited. For many years quinine was separated from the total alkaloids of cinchona bark under the impression that it was the only effective alkaloid against malarial infections. The isolation and refining of this alkaloid naturally made it more expensive. The researches of Acton, McGilchrist, and Fletcher have conclusively shown that the other three of the main alkaloids occurring in the bark are also effective against this widespread disease in the tropics. The total alkaloids of the bark in the form of cinchona febrifuge were, therefore, extensively tried and after careful observations, have been found to be quite as effective as the purified quinine itself. During the World Wars I and II, the price of quinine went up to nearly Rs. 100/- or more per lb., and although it came down to Rs. 40/- per lb., recently, it is still too high for the economic condition of the masses in this country. The result is that most of the hospitals and dispensaries in the mofussil whose annual budgets are not very generous or extensive can only afford limited quantities of essential antimalarial drugs. In order to supply those the supply of other often important drugs has to be curtailed. The substitution of the total crude alkaloids (cinchona febrifuge) in the place of purified quinine will effect a great saving. We have dealt with this question more fully under cinchona. The total alkaloids of ipecacuanha have also been shown to be nearly as effective against amoebiasis, which is also very prevalent in this country, as pure emetine. Then again in the case of *Holarrhena antidysenterica* it has been found that the total alkaloids and the galenical preparations made from the bark are better than purified conessine. The tincture made from *Ephedra vulgaris*, is just as effective in the treatment of asthma, cardiac failure, etc., as the expensive alkaloid ephedrine. Such examples could be multiplied. It should be possible to prepare tablets from many of the indigenous drugs which could be sold at a very cheap price. Attention to this subject is of great importance to this country because economy and low cost of advice and treatment are of paramount importance to any plan of medical relief that can hope to succeed in this country.

XII

Development of Allied Industries: SOLVENTS.—The manufacture of refined chemicals, alkaloids, etc., for medicinal use can also be easily undertaken by the existing manufacturing firms on a much larger scale but the question of solvents which have to be extensively employed is a difficult one. With the exception of alcohol most of the solvents such as chloroform, ether, benzene, petroleum, etc. are available in limited quantities and a high price has to be paid for them. Even in the case of alcohol although the actual cost of production of rectified spirit at present is about Rs. 1-8-0 per imperial gallon, the excise duty charged on it is Rs. 37-8-0, i.e., nearly 16 times the cost of manufacture of alcohol. It is true

that for medicinal purposes a special concession rate of Rs. 5-0-0 per proof gallon (bulk Rs. 7-4-0) is allowed to certain drug manufacturers with bonded stores, but in spite of this the price of spirituous preparations is beyond the means of the poor masses. Unless an appreciable reduction is made in the price of the alcohol used for medicinal purposes, it will be impossible to bring down the price of the preparations to the economic level of the Indian peasant.

Benzene and petroleum are two solvents which come next in importance to alcohol. Both of them could be easily manufactured on a large scale from raw materials available, at a very cheap price. Benzene could be manufactured from coal in the coalfields. It is being manufactured by one or two firms of coke oven owners, but whereas the cost in other countries is one shilling or so per gallon, in India it is being sold at Rs. 1-10-0 per gallon plus a duty of 6 annas; only a limited supply, not nearly sufficient to meet the demand, is available even at this high price. Most of the by-products in the production of coke are being allowed to go waste. The other solvents such as acetone and glycerin could also be easily manufactured. Acetone is prepared from wood shavings and sawdust. Enormous quantities of raw material are available as about one-ninth of the total area of this vast country is covered with forests. In spite of this there are only one or two acetone factories in the whole of India at the present time. Enormous quantities of glycerin are being thrown away in the form of soap wash lye from soap factories in India, which could be recovered. There are a few firms of soap manufacturers in India on a sufficiently large scale, to be able economically to recover glycerin to compete with the prices at which the imported product is sold. Over 90 per cent. of the machinery required for pharmaceutical factories is at present being imported from America and Europe. All this could be easily manufactured in India and at much cheaper prices. The development of various industries in connection with drug manufacture in itself has a great future.

XIII

Cultivation of Medicinal Plants: UTILISATION OF FOREST RESOURCES.—We will now touch on the important question of the cultivation of drugs on a commercial scale in this country. India is a veritable emporium of medicinal plants; nearly three-fourths of the drugs mentioned in the British and other pharmacopoeias grow here in a state of nature. Not only has the country great resources so far as the medicinal plants are concerned, but many kinds of perfumes and spices which are known all over the world abound in it. India possesses climatic conditions varying from the torrid to the frigid zone. It embraces vast tracts of tropical plants, temperate hills and valleys, irrigated soil, moist and dry climates and cheap labour. It has in fact been described as an epitome of climates, seasons and soils of the world. It is, therefore, possible that the drugs which do not naturally grow within her bounds could be easily made to do so. Acclimatisation is possible to a large extent with almost any plant and there are many instances where plants, indigenous in one country and originally marketed

from one country only, have been introduced into other countries and established on a very firm foundation.

So far reliance has been mostly placed on the natural resources of the country and the drugs growing in a state of nature alone have been chiefly collected and utilised. The fact should, however, be appreciated that although the country embraces every climate and situation, the great obstacle to the development of forest drug resources has always been the question of transport. These forests in many instances are situated hundreds of miles away from the railheads and the cost of transport would be prohibitive. The transport facilities have, however, been greatly improved during recent years and the advent of motor transport has brought distant places within reach. The Forest Departments of States, we have no doubt, leave no stone unturned to utilise all their resources to the fullest extent and already there are signs of activity. With the setting up of the Indian Council of Agricultural Research and the Council of Scientific and Industrial Research as well as the Indian Council of Medical Research and the large research grants these bodies give, the subject of cultivation of medicinal plants is receiving the attention it deserves, and the drug resources of the country are being gradually developed to their full extent.

The collection of drugs scattered in forests is troublesome and often the cost of collection raises considerably the price of the drugs and their preparations. The disadvantages regarding the collection of drugs when they are growing in a state of nature in scattered areas are: (a) difficulty of access and transport when the natural home of the drug plant is far way; (b) sparse distribution; (c) indiscriminate collection which may lead to exterminations; this nearly occurred in case of belladonna and rauwolfia; (d) ignorance of the collectors generally leading to the admixture of genuine with spurious plants.

It is on account of these difficulties in the collection of medicinal plants growing wild, that a suggestion to cultivate them is made. On account of the great diversity in climate and soil in India, it is possible to introduce into this country plants from every region of the world. India can in this way become independent of her foreign imports of crude drugs. In order to ensure a regular supply of all drugs of standard quality to the pharmaceutical industry, it is essential that drugs growing in a state of nature should be brought under systematic cultivation and those which are exotics should be introduced and cultivated. The experimental cultivation of some of the exotic plants was started in India as long ago as the beginning of the eighteenth century. Medicinal plants such as digitalis, cinchona, ipecacuanha, pyrethrum, etc., have been tried both by Government and private agencies, in botanical gardens and in the tea and coffee plantations. It has been observed that the exotics have grown well, and after a few years' culture have adapted themselves to the Indian soil in a remarkable manner. Many of these are now grown in this country on a commercial scale.

During the period of normal world trade the problem of securing our inflexible vegetable drugs is not difficult; little interest is, therefore, taken in

new sources, particularly as drug plants are not usually regarded as easily saleable cash crops. It is only during a widespread war, such as the one we have passed through recently, when the usual sources of supply fail that the possibility of securing these plant products from local sources receive any serious consideration. During World War II India found herself totally deprived of the supply of many essential drugs, even those growing within her bounds were not available in sufficient quantities. On account of the acute shortage of drugs which occurred during this period, it was realised that something should be done towards the systematic cultivation of medicinal plants. Many interested persons, attracted by the prevailing high prices, proposed programmes of cultivating medicinal plants to the Government which met with approval. A point which is often lost sight of is that this type of cultivation is a specialist's job, and anybody with a little knowledge of agriculture or botany is not competent to undertake this work successfully. Such factors as culture, soil, disease and harvesting, must be considered before it can be ascertained whether a plant can be grown successfully in any region. This is illustrated by the way in which cinchona and coca plantation were carried out in India and in the Dutch East Indies. The earliest attempt at cultivating cinchona was by Sir Clements Markham when he started a cinchona plantation in Darjeeling hills. The Dutch plant culturists started the work very much later, but through better cultural methods, proper selection of species and hybridisation, they succeeded in controlling the world market for cinchona products, while India cannot produce sufficient for her own needs even now. Similarly, India made abortive attempts early in this century to grow coca plants in the Nilgiris and Travancore hills, while the Dutch succeeded in establishing its (*Erythroxylum truxillense* in place of *E. coca*) cultivation on a large scale in Java. Many such examples can be cited. Plant culture methods have now developed to such an extent that even plants which are strictly of tropical origin are being made to grow successfully in temperate or other climates under artificial conditions, in the interests of national self-sufficiency and national defence. In India with her natural climatic advantage and comparatively cheap labour, there is no reason why success should not be achieved if the problem is tackled in a scientific manner. For this purpose collaboration between plant culturists, botanists, chemists, pharmacologists and entomologists is essential. The difficulties are sometimes so varied that joint efforts would be necessary to establish the proper species or hybrids in any particular locality. The necessary scientific talent is available in India and should be harnessed.

The urgent need for the cultivation of medicinal plants and for the development of sources of many natural products of vegetable origin within the British Commonwealth of Nations was voiced in 1941 by the Therapeutic Requirements Committee of the Medical Research Council, Great Britain. The following drugs were recommended for production:—

- (1) Acidum tartaricum; (2) Agar; (3) Balsamum toltanum; (4) many insti. (5) Calumba; (6) Camphor; (7) Cantharides; (8) Cascara sagrada; (9) arabin; (10) Cinchona; (11) Coca; (12) Colophony; (13)

Creosote; (14) *Datura*; (15) *Derris*; (16) *Ephedrine*; (17) *Ergot*; (18) *Gentian*; (19) *Glycyrrhiza*; (20) *Hamamelis*; (21) *Hyoscyamus muticus*; (22) *Ipecacuanha*; (23) *Jaborandi*; (24) *Krameria*; (25) *Lobelia*; (26) *Menthol*; (27) *Mylabris*; (28) *Oleum cadinum*; (29) *Oleum amygdalæ*; (30) *Oleum anisi*; (31) *Oleum chenopodii*; (32) *Oleum menthæ piperitæ*; (33) *Santonin*; (34) *Scilla*; (35) *Storax*; (36) *Thymol*; (37) *Tragacanth*.

India has no sources or poor sources for balsam tolu, camphor, cascara sagrada, cysarobin, hamamelis, jaborandi, krameria, menthol, storax, and thymol, but she can easily take care of the others with comparatively modest enterprise. During World War II through the efforts of the Medical Department and the Supply Directorate (Medical Division) considerable amount of work was done in this direction, and India is now self-supporting in as many as 17 to 18 items, e.g., agar, cantharides, colophony, datura, ephedra, gentian, glycyrrhiza, hyoscyamus, lobelia, oleum amygdalæ, oleum limonis, oleum terebinthinæ, psyllium, rhubarb, santonin, scilla, tragacanth, out of a total of 39 vegetable drugs recommended for production by the Medical Research Council. With further efforts more success is likely to be achieved.

CULTIVATION OF DRUG PLANTS IN FOREIGN COUNTRIES.—Cultivation of medicinal plants was taken up in almost all the countries in Europe including the United Kingdom, the U.S.A. and U.S.S.R. by the State as well as by manufacturing pharmaceutical concerns. In the U. S. A. the Plant Introduction Service was organised by the State Department of Agriculture as long ago as 1903 and such organisations exist in Germany, Belgium, Holland, France and Soviet Russia. These organisations are doing splendid work in connection with the introduction and cultivation of plants of economic importance.

The American organisation helps, in addition to other activities, medicinal plant culture by publishing statistical information showing the principal markets for such products nearest to their point of production and establishes liaison with countries through diplomatic and other channels. In this way procurement of seeds and other agricultural information concerning necessary acclimatisation of new crops of economic or industrial significance can be obtained.

Peppermint oil has been produced in England, France, and Italy, from very much earlier times than in the United States of America, but through systematised cultural methods and better methods of distillation, the American production has established for itself a predominating place in the world supply. Spearmint (*Mentha viridis*) and Japanese peppermint (*Mentha arvensis* var. *piperascens*) have also been introduced in the United States through the mediation of the Plant Introduction Organisation.

Need for setting up an organisation similar to the Bureau of Plant Introduction and Exploration was long felt in India. Fortunately a beginning has been recently made under the auspices of the Indian Council of Agricultural Research. Although the Bureau is still in its infancy, it is hoped that it will obtain all the necessary information regarding the cultivation of exotics and will gather infor-

mation regarding plants of economic importance suited for climatic conditions in this country. Statistical data regarding acreage under medicinal plants and quantity of yield per acre are not available in India. Information regarding import and export of individual crude drugs is also wanting. This Bureau should be able to collect and supply this information which is so vital for those who wish to take up this work.

The cultivation of plants for bioaesthetic purposes is becoming popular in this country. It would be worthwhile if beautiful trees, especially those which have medicinal properties, are propagated. There are many such trees, e.g., *Cassia fistula*, *Strophanthus kombe*, and shrub-like *Rosmarinus officinalis* and many others which can beautify the countryside and also yield medicinal drugs. This organisation can advise the cultivation of many such plants for economic and bioaesthetic purposes. The Bureau can make trial cultivation of exotics in different localities in the country with varying climatic conditions. There are many forest nurseries and botanical gardens scattered all over the Indian subcontinent which could be utilised for this purpose.

DRUG CULTIVATION IN INDIA.—Important medicinal plants such as digitalis, ipecacuanha, cinchona, jalap, etc., are already being grown, and there is no reason why the country should not grow every drug to supply her own needs, if not for export. Vast tracts of land are lying waste at present in the country which if utilised for the cultivation of drugs will not only enrich those concerned in the enterprise but will give the people of the soil drugs at a reasonable price. The great advantage accruing from a systematic cultivation of drugs is that a regular supply of genuine drugs of a standard quality can be assured. Of the non-food crops, the drugs and narcotics occupy about 2.6 million acres, i.e., 0.8 per cent. of the total area of land under cultivation. The Government plantations for the cultivation of cinchona though nominally nearly 15,000 acres actually occupy not much more than 6,000 acres. Narcotics, such as hemp, tobacco, opium, etc., occupy a comparatively small acreage. It would appear from this that, with the exception of cinchona and a few small experimental farms for other drugs in places like Kashmir, Saharanpur, Coimbatore and Ootacamund in south India, very little is being done at present to foster the cultivation of medicinal plants. This fact is indeed deplorable.

The idea of cultivation of medicinal plants in botanical gardens under expert guidance is not a new one. As early as the sixteenth and seventeenth centuries botanical gardens for the cultivation of drug plants existed and great interest was exhibited in their maintenance. In 1560, there were fifty such gardens in Italy. The botanical garden of Pisa and the drug garden at Padua, which are said to have been started somewhere in the year 1546, still exist. The drug emporium at Leiden in Holland dates from 1575. In India, botanical gardens for cultivation of drugs were reared under highly qualified specialists during the Buddhistic regime. There is evidence to show that Asoka the Great had a special fancy in this direction and subscribed large grants from the state funds towards their development. In this generation, the utility of drug gardens is also fully appreciated by the people,

but the chief reason which seems to have kept this important scheme in the background is that grave doubts have been expressed in many quarters regarding the financial success of medicinal plant cultivation in this country. Although the consumption of vegetable drugs has decreased during the last 50 years and the synthetic preparations are fast replacing the drugs elaborated in nature's laboratories, the former are still largely used. The production of vegetable drugs and their use in fact has actually increased in many places. In countries such as Germany and Belgium medicinal plants and essential-oil gardens have proved a great success. The state in France is taking a great deal of interest in growing drugs on a large scale and in the United States of America medicinal herbs are being cultivated on an industrial scale and the cultivators are reaping a rich harvest and making large profits. More interest created in this direction will be greatly to the advantage of all concerned.

Many of the drugs concern the Forest Department, but the Department of Agriculture would also be interested in a very large number of them. The co-operation of expert botanists, pharmaceutical chemists and pharmacologists is essential for the success of such a scheme. They can not only advise regarding the locality where particular drugs can be successfully cultivated, but also the time suitable for cultivation, collection, etc., to get the maximum activity and yield of their active principles. They can devise methods for improving the contents of the active principle where they are deficient. A detailed study of the chemistry of the Indian medicinal plants will not only contribute new facts to the science of drug chemistry, but such a study is bound to bring them to the notice of the medical profession in India and elsewhere. Work done on *Artemisia maritima* illustrates how the artificial cultivation and acclimatisation of a drug can be effected, and how improvement in the contents of active principles can be brought about by scientific cultivation. *Artemisia* containing santonin was believed to grow only in Russian Turkestan, but during the World War I, when that supply was cut off, Van Laren by scientifically studying the nature and habitat of the plant successfully grew *Artemisia cina* in Holland, which gave a fairly high yield of active principles. Then again *Artemisia* growing in a state of nature in the Russian Turkestan had a santonin content of 1.5 to 2.6 per cent., but by proper cultivation the amount of active principles could be increased from 2.6 to 3.6 per cent.

Indiscriminate exploitation of such plants as rauwolfia, belladonna, etc., during recent years had resulted in an almost complete depletion of many of our valuable natural resources both in the field of medicinal plants and condiments and spices. A great set-back has also come due to transfer of certain territories rich in medicinal plants to Pakistan. The supply of glycyrrhiza, ephedra, artemisia, and asafoetida, which were mainly the products of frontier areas of West Pakistan and Baluchistan has been cut-off. There is also either deliberate or innocent adulteration because of lack of proper knowledge on the part of collectors. Collection is often done without taking into consideration the proper season and

other factors. All these factors bring out the necessity of cultivation of medicinal plants on scientific lines for supply of crude drugs to the pharmaceutical industry.

It is satisfactory to note that more interest is being taken in drug cultivation in India. A number of drug farms have been started. In Kashmir, digitalis, belladonna, hyoscyamus, pyrethrum, senna, have proved successful in certain parts. In Mysore State the experimental cultivation of a number of plants such as wattle, pyrethrum, derris, cinchona, geranium, peppermint and tung tree, is already a success and large scale cultivation of these is being contemplated.

The Indian Council of Agricultural Research, through its Medicinal Plants Committee, are also sponsoring such activity in several zones in north-eastern, northern and southern India. Attention is being paid not only to the cultivation of indigenous plants but also towards the introduction of exotic plants such as *Datura innoxia* from Mexico and *Duboisia species* from Australia as better sources of hyoscyamine, *Urgine scilla* from Mediterranean coasts and *Coriandrum sativum* and *Foeniculum vulgaris* from Russia, and Germany, and *Heliopsis longipes* as a better source of pyrethrum from Mexico. Such efforts by research workers aided by agricultural and horticultural experts would increase the potential wealth of the country and our dependence for these on other countries would vanish.

Improvements of economic plants by cultivation is a fascinating study and is directly concerned with the production of better quality of crude drugs in India. Grafting, selection, hybridisation, induction of mutagenic variants by radiation and chemical agents, and production of polyploidy by colchicine treatment are some of the methods employed in this direction. Much work has been done in other countries but in India only a beginning has been made towards bringing about improvements in crop plants. A few medicinal plants such as *Hyoscyamus niger*, *Datura metel*, *Ocimum basilicum*, etc., have also been treated in this way. This promising field of investigation which is yet largely unexploited is likely to lead to very promising results.

Investigations on these lines would undoubtedly open up a vast field of research to the chemists and pharmacologists, the scientific and economic importance of which is difficult to overrate. It goes without saying that scientific research in the modern world is the basis of economic improvement. Large co-operative and business agencies are developing their research departments at very large expense and consider it a profitable investment. Systematic research in connection with cultivation of medicinal plants would be of immense benefit to the country.

XIV

A Retrospect of Results Achieved.—The systematic investigation of drugs used in indigenous medicine on modern scientific lines was started more than thirty years ago and comparatively speaking much has been accomplished during this short space of time. A number of important medicinal plants prescribed by the Kavirajes, Hakims, etc., have been carefully investigated from every point of

view. Their chemical composition has been determined, the pharmacological action of the active principles worked out by animal experimentation, and finally suitable preparations made from the drugs have been tested on patients in the hospital. It is only by such a thorough enquiry that the real merits of these drugs can be proved and a demand created for them not only in India but in other parts of the world. This laborious work has brought into prominence the merits and qualities of certain drugs and it has been shown that, if brought into general use they may prove to be very valuable additions to the present armamentarium of the medical man to relieve the sufferings of humanity.

With the growth of pharmaceutical institutions and chemical laboratories in universities and also in pharmaceutical concerns in India, a good deal of progress in this work has been made. Such work has brought out the merits and qualities of certain drugs such as *Holarrhena antidysenterica*, *Rauwolfia serpentina*, *Butea frondosa*, *Alstonia scholaris*, *Casalpinia bonducella*, *Adhatoda vasica*, *Bacopa herba*, *Damia extensa*, *Cissampelos pareira*, *Terminalia arjuna*, *Psoralea corylifolia*, *Sida cordifolia*, *Swertia chirata*, *Andrographis paniculata*, *Plantago ovata*, *Thevetia neriifolia*, *Rivea cuneata*, and others. *Holarrhena* (Kurchi) has come to stay as a reliable anti-dysenteric remedy, particularly in sub-acute and chronic forms of amoebiasis complicated with what has often been described clinically as 'post-dysenteric abdomen'. Standardised liquid extract and a preparation, Kurchi Bismuth Iodide have been accepted as recognised remedies in the Indian Pharmacopoeial List and Indian Pharmaceutical Codex. During the Second World War, Kurchi Bismuth Iodide was used in Eastern Theatres of War with very satisfactory results. *Rauwolfia*, an old drug used by Indigenous practitioners in this country for centuries past as a purgative, anthelmintic, and as an antidote in snake bite and more recently in clinical medicine in this country as a hypotensive agent and as a sedative in the treatment of insomnia and certain forms of insanity has been introduced into clinical medicine in America as one of the best remedies for the treatment of hypertension. The first pharmacological paper on this sovereign remedy was published as far back as 1933 by Chopra and Mukerji. Since then a large number of papers have been published in India and abroad giving details of its active principles and the pharmacological action of the alkaloidal and other bodies contained in it. Recent work on *C. pareira* has given indication that from this Indian plant, growing abundantly in the lower ranges of the Himalayas, a substance has been isolated which is as good a smooth muscle relaxant as d-tubocurarine chloride. From *T. neriifolia*, a pure glycoside has been obtained having properties and uses similar to digitalis. In *A. paniculata*, and *S. chirata*, are present bitters and cholagogues which favourably compare with the best items of their class in foreign pharmacopoeias. The use of *P. ovata*, introduced by Unani and Tibbi medicine into India has now been accepted all over the world as an excellent agent in irritating conditions of the gastro-intestinal tract.

There is still a vast field (about 2,000 remedies) to be investigated and there is likelihood that some of these may be effective in the treatment of disease. Even

if a few successful finds are made, it is well worth probing deep into this rich *materia medica*.

A large number of other drugs examined showed a certain amount of activity but were not found to be superior to the drugs already possessed by the pharmacopoeias. Many of these can be used as cheaper substitute for pharmacopoeial remedies which although used were found to have little or no activity. Many drugs of questionable value and doubtful utility crept into the indigenous systems during the period of decay. We hope to discuss all the drugs on which investigation has been carried out later; it will not, however, be possible to enter into the details of all the aspects of this work. For this, reference should be made to the original papers published from time to time a list of which has been given elsewhere.

Apart from establishing the value of many useful remedies there is another aspect of this work which should not be neglected in our survey. At the present time most of the drugs used in indigenous medicine are supposed to be specifics for some particular diseases and lay people will wax eloquent in their descriptions of the wonderful cures said to have been produced by some of these remedies. Glowing statements of this nature, supported by insufficient evidence, have sometime appeared even in medical journals. This has done a great deal of harm to their reputation, and distinguished pharmacologists and clinicians of Europe and America are beginning to be pessimistic and to doubt if there is really anything of much value in the vast array of the *materia medica* of the indigenous medicine. They are inclined to take the view that an investigation into the properties of these drugs is not likely to lead to any material results. In this way the reputation of these remedies has grievously suffered in Western medicine, the good ones being indiscriminately classed with the bad. Only systematic research of this kind can establish the value of the useful ones. Thereby the chaos that exists in these drugs will be removed and the true teachings of the Ayurvedic and Tibbi medicine will become available to all the world.

XV

Preparation of Indian Pharmacopoeia.—This brings us to the last proposition, i.e., the preparation of an Indian Pharmacopoeia. The object of a Pharmacopoeia is, in the words of the founders of the United States Pharmacopoeia, 1820 "to select from among substances which have medicinal power, those, the utility of which is most fully established and best understood, and to form from them preparations and compositions, in which their powers may be exerted to the greatest advantage".

The modern pharmacopoeia is above all a book of standards. Its fundamental object and scope is, "to provide standards for the drugs and medicines of therapeutic usefulness or pharmaceutic necessity sufficiently used in medical practice; to lay down tests for the identity, quality and purity, to insure, as far as possible, uniformity in physical properties and active constituents". In other

words, usage, rational usage, and scientific usage, are the basis of judgement. It is, however, the chief bulwark of one of the most time-honoured principles of the medical profession, namely that there must be no secrets about the drugs used in the treatment of disease. Upon this question that physicians must have full knowledge of all the constituents and of all the properties of the drugs they prescribe, there can be no compromise. The physician should never forget that he is the sole judge of what is suitable for his patient.

Apart from the fact that there is an almost universal demand from both physicians and pharmacists, its preparation has cogent scientific reasons to favour it. The methods of therapy vary in different countries. The raw materials from which medicinal drugs are prepared do not possess the same qualities and may not be available so readily in one part as in another. The altitude, the season, the climatic conditions, the time of collection, etc., are some of the important factors determining the activity of medicinal plants. A plant showing remarkable activity in one part of the world may be inactive when collected from another. The bark, roots, leaves, etc., vary in their active constituents, and what is used in one country may not be suitable for another. Again, there are racial variations in dosage. What is an effective dose for a European may not be so for an Indian. We have already referred to the effect which the climatic conditions have on the pharmaceutical processes. The unsuitability of the pharmacopoeia of one country for another is, therefore, obvious. Each country should evolve a pharmacopoeia best suited to its own peculiar climatic and racial factors, with due regard to the raw materials available.

The pharmacopoeia which is in view ought to include the therapeutically active substances and, to find admission to it, a drug must be of known composition, of definite pharmacological action, and of well-established therapeutic use, and fully investigated for its toxicity and necessary standard for determining a safe maximum dose, with a chemical or biological standard. The large mass which do not satisfy this condition should be left out. Necessary tests have to be developed for the protection of doctor, pharmacist, and patient. India ought to set a standard of strength and purity for the material which is to appear on her markets. It is a matter of great satisfaction to note here that the goal in this connection has practically been achieved.

An Indian Pharmacopoeial List was compiled in 1946 by a Committee appointed by the Government of India under the auspices of Drugs Technical Advisory Board. This contains a list of drugs in use in India which, although not included in British and other pharmacopoeias, are of sufficient medicinal value to justify their inclusion in official pharmacopoeia. This Committee also worked out and recommended what standards should be prescribed to secure uniformity and what tests should be used to establish identity and purity. This list contains more than three hundred vegetable drugs of Indian origin. Their representative Indian names in various states are included. This list has formed the basis for the preparation of an Indian Pharmacopoeia, the first edition of which is nearly

ready for publication and which will satisfy all the requirements of a modern scientific pharmacopoeia.

XVI

Chemical Constituents of Medicinal Plants.—The active principles of both the medicinal and poisonous plants are often definite chemical substances but in other cases they are complicated mixtures. Briefly the following group of substances occur in plants and are responsible for their medicinal as well as their toxic properties:—

(1) The first class of these substances with medicinal and toxic properties are vegetable bases which include amines and alkaloids. As a class these bodies are characterised by their profound physiological action and in many cases their intensely poisonous nature. Some of the amines give a foetid odour to some weeds, and to some mushrooms their poisonous characters. The alkaloids as a rule give a bitter taste to a plant in which they naturally occur, and that in itself is frequently a sufficient protection against livestock eating it, except in unusual cases of hunger. A considerable number of medicinal drugs owe their curative properties to these principles. The grasses as a rule do not contain these bases but they do occur in many of the other families. Examples of alkaloids are strychnine from *nux vomica*, aconitine from *aconites*, atropine and allied alkaloids from *belladonna*, nicotine from tobacco, morphine from poppy, etc.

(2) Another class of these substances are represented by glycosides which form a large group and are much wider in occurrence than alkaloids. Many are non-toxic but quite a large number of them are intensely poisonous. They have generally a bitter taste and occur in many of the plant extracts used in medicine. Well-known examples of toxic glycosides are those occurring in the *Oleander* family (*Apocynaceæ*) and *Digitalis* (*Scrophulariaceæ*).

A group of glycosides which are important from the point of view of livestock poisoning is represented by the cyanogenetic glycosides which contain hydrocyanic acid bound up in them; this is liberated by enzymes mostly occurring in the plants. As the name implies they split in the animal body, liberating sufficient quantities of hydrocyanic acid to produce fatal results. The well-known representative of this class is one occurring in bitter almonds and known as amygdalin. They also occur in a number of grasses and members of the pea and rose families, etc.

Another group of glycosides, when agitated with water, produce soapy foam and to these the name of saponins is given. In the vegetable kingdom they occur in at least 400 plants belonging to 50 different families. They are particularly poisonous to certain lower animals, for example fishes, frogs, insects, etc. The fishes are killed by these bodies in such high dilutions as 1 in 2,00,000 or more. In higher animals, when taken by mouth, they produce gastro-intestinal irritation, vomiting and diarrhoea. In cold-blooded animals, such as fishes, they produce

paralysis of the respiratory organs. They produce haemolysis when they come in contact with blood and have an acrid taste. Common examples containing saponins are soap-nut, soap-bark and soap-root.

(3) The third group of active substances is furnished by essential or volatile oils which give characteristic odours to plants. These bodies are characterised by their insecticidal and insect-repellent properties, while in man and livestock they produce toxic effects by gastro-intestinal irritation. Common examples are those occurring in eucalyptus, in absinth which produces convulsions by its action on the nervous system, the Pine family and that produced from mustard seed by the action of an enzyme, etc. Cattle do not as a rule feed on the plants containing the toxic essential oils.

(4) The fourth group of toxic substances are known as toxalbumins which occur in castor, croton, and abrus seeds. These are essentially blood-poisons and are responsible for frequent losses among livestock. Animals can, however, become immune to these bodies if they are given in small and gradually increasing doses, but the immunity is of a specific nature, i.e., against that particular toxalbumin and not against others.

(5) The fifth group of substances are called resins such as those occurring in podophyllum, bitters such as are found in wild members of the Cucumber family, for example colocynth, phenolic compounds such as those found in many members of the Cashew family. Other highly toxic principles are andromedotoxin occurring in many members of the Rhododendron family, toxic oils such as croton oil, picrotoxin, a convulsant poison found in *Anamirta cocculus* (Linn.) W. and A. (poison berry) which is a climbing shrub of the Indian forests, and neutral principles, organic acids and their salts, etc. All these have been responsible for poisoning in man and animals.

(6) The sixth group of active substances occurring in plants are the antibiotics. It is well-known that some of the most powerful antibiotics now in use such as penicillin, streptomycin, etc., are derived from the lower form of vegetable life, i.e., fungi. Although some work has already been done on occurrence of antibiotics in higher plants—phanerograms—and antibiotics have been found in them, none of these, so far have come up to those obtained from the fungi in their potency as therapeutic agents. We are, however, just at the threshold of this vast field and it is possible that many powerful antibiotics will be discovered in higher plant.

FACTORS AFFECTING PHYSIOLOGICAL ACTION AND TOXICITY.—The amount of active substances present in plants is dependent upon several factors, for example the nature of the soil, the climate, the season, the stage of growth of a plant, the nature and intensity of light, cultivation, etc. Fresh, green plants may be poisonous and in a dried condition the toxicity may be lost, for example in buttercups and other plants which have volatile active principles. Toxicity may be lost by cultivation as in the case of gourds, while the toxic principles in Cinchona and Oleander do not deteriorate through cultivation. The stage of growth of a

plant is perhaps the most important factor in determining its physiological activity and toxicity.

Susceptibility of animals to plants varies enormously. Rabbits are insensitive to the atropine group and birds stand large doses of strychnine. Young mammals are generally more susceptible than old. The condition of the animal, personal idiosyncrasy, tolerance and immunity also play a part in determining the degree of susceptibility to the poison.

XVII

Correlation of Botanical Classification of Plants, Their Chemical Constitution and Physiological Properties: ACTIVE PRINCIPLES AND NEW CLASSIFICATION.—With the advance of knowledge of the chemistry and pharmacology of plants, it appears to be certain that some correlation exists between the botanical classification of plants, their chemical constitution and physiological properties. One is frequently struck with the remarkable resemblance exhibited by closely-allied plants in this respect. For example, if a particular chemical constituent is found in one member of the genus, there is considerable likelihood of the presence of constituents with identical or similar physiological properties in other members of the genus or of the family. This does not, of course, mean that such similarity will not be found in other families or genera just as particular taxonomic characters may be spread over widely different families and genera. An ideal classification of plants would be the one which in addition to satisfying botanical criteria broadly provides an index to the nature of their chemical constituents and physiological properties. With our existing knowledge this is not possible. The very fact that some of the families and genera, as at present understood, are quite homogeneous in these respects, however, reflects a ray of hope that after all the problem is not so difficult as it appears at first sight. Considerable work on the chemistry of plants and the determination of the physiological properties of their active principles, however, will have to be carried out and thousands of new plants will have to be investigated before this is attained, or the attempt given up as hopeless. This should not, however, be understood to imply that advances in the knowledge of chemistry and pharmacology should determine the botanical classification of plants. This is not possible as such features cannot possibly serve as taxonomic characters. But it is hoped that botanists, chemists, and pharmacologists will collaborate in evolving a natural system of classification based on their combined efforts.

CHEMICAL CONSTITUENTS.—A brief review of the distribution of the more important and potent chemical constituents of the Indian flowering plants of widely different families and genera presents certain very interesting features. The alkaloids are distributed over about 40 families and there are a number of cases where the same alkaloid is found in closely allied genera and families. Thus, berberine has been recorded from six different families and twelve genera. Ephedrine, on the other hand furnishes an example wherein a particular alkaloid

may be found in plants belonging to widely different groups; it has been found in *Sida cordifolia* Linn. of Malvaceæ (a family belonging to Angiospermæ) and in *Ephedra* of Gnetaceæ (a family belonging to Gymnospermæ). Purines are found in three families.

The glycosides form a large group and are much wider in occurrence than the alkaloids, occurring both in Dicotyledons and Monocotyledons; some of these are very toxic and occur in eight widely different families. Hydrocyanic-acid yielding plants belong to ten families. A group of glycosides known as saponins is of very wide occurrence in the vegetable kingdom; saponins are known from at least 400 plants belonging to 50 different families occurring almost all over the world. Essential oils are of wide occurrence in the vegetable kingdom though certain families, such as Labiatae, Rutaceæ, Umbelliferae, Myrtaceæ, Lauraceæ, Cruciferae, and Coniferae, are especially rich in these substances.

The seeds of numerous plants contain albumins, but it is interesting to note that certain plants, such as *Abrus precatorius* Linn. and *Ricinus communis* Linn. belonging to very different families (Leguminosæ and Euphorbiaceæ respectively) wherein the toxicity of these albumins is of a similar nature, both being essentially blood-poisons, and both similar in their immunity reactions if introduced into the body of animals in small and gradually increasing doses. It is not proposed to go into further details of several other chemical constituents, nor even of such toxic complexes as resins, phenolic compounds, etc. The few examples cited provide sufficient evidence in support of the now well-established theory of organic evolution. There seems to be a method in their occurrence; in several cases it is due to their descent from common ancestors while in others it is a result of parallel evolution. The facts described above cannot be explained on any other basis.

EXAMPLES OF CORRELATION.—We will now cite a few examples of some families and genera to show the marked resemblances between their botanical, chemical and pharmacological aspects. Unless definitely proved as harmless it is advisable, for instance to regard all members of Ranunculaceæ a potentially poisonous, especially when fresh, both for human beings and livestock. Poisonous, acrid, vesicant, purgative and narcotic properties prevail in varying degree throughout the family. Species of *Anemone*, *Caltha*, *Clematis*, and *Ranunculus*, contain the lactone anemonin which has blistering properties. Most of the aconites contain highly poisonous alkaloids which act mainly on the sensory nerves and on the medulla which they depress and ultimately paralyse. Species of *Delphinium* are used for the destruction of vermin and contain toxic alkaloids, some of which appear to act like aconitine, while others paralyse the motor nerves. Alkaloids are also known to occur in the genera *Coptis*, *Helleborus*, *Nigella*, *Isopyrum*, and *Pæonia*. *Adonis* and *Helleborus* contain glycosides with a digitalis-like action. Saponins are found in the genera *Clematis*, *Ranunculus*, *Nigella*, and *Cimicifuga*. Cyanogenetic compounds have been reported from some of the members of the family and the Indian representatives from which these principles have been reported belong to the genera *Clematis*, *Aquilegia*, *Isopyrum* and *Ranunculus*.

Seeds of *Anona* of *Anonaceæ* have insecticidal properties and are powerful irritants of the conjunctiva. Several species of *Berberis* contain active principles poisonous to fishes and dogs. Many species of *Papaver* have a juice with narcotic properties and contain powerful alkaloids. Narcotic properties are also possessed by some other members of the family *Papaveraceæ*, e.g. *Meconopsis*. Most *Crucifers* have pungent juices and many have glycosides in their seeds and produce very irritant essential oils; they possess stimulant properties. Several plants of *Caryophyllaceæ* contain saponins. The family *Rutaceæ* is characterised by the presence of essential oils some of which are toxic. Many plants belonging to *Sapiindaceæ* have saponins and a number of them are well-known as fish poisons. *Anacardiaceæ* are usually provided with more or less acrid resinous, sometimes milky juices; very many species of this family possess astringent properties. Plants of no less than twenty-seven genera of *Leguminosæ* possess insecticidal or piscicidal properties. The poisonous properties of *Rosaceæ* are generally due to the presence of cyanogenetic compounds. The presence of powerful bitter and purgative principles is the prevailing characteristic of the wild members of *Cucurbitaceæ*. Aromatic members of *Umbelliferæ* are usually carminative, while the non-aromatic members are often acrid and narcotic and should be taken with care. Alkaloids with similar physiological properties are the outstanding constituents of the genus *Cinchona*. *Lobelias* belonging to *Campanulaceæ* yield an intensely acrid milky juice and the dust of the powdered herbs irritates the nostrils in the same way as tobacco; they contain alkaloids. *Rhododendrons*, mask under the beauty of their flowers, very fatal active principles and the family *Ericaceæ* to which they belong contains several insecticidal plants; the toxic substance andromedotoxin is very common in this family. *Apocynaceæ* includes several plants which are highly poisonous, the properties of most of them being due to glycosides with a digitalis-like action and physiologically active alkaloids. Many species of *Asclepiadaceæ* contain acrid, bitter, and poisonous juice. The genus *Strychnos* is rich in alkaloids which are violent tetanic poisons. Many species of *Convolvulaceæ* have an acrid taste and contain active purgative principles. Mydriatic alkaloids such as atropine, hyoscyne and hyoscyamine are found in several species of *Solanaceæ* while the glycosidal alkaloid solanine is found in many *Solanums* and some other genera as well; a very large number of wild plants of this family are poisonous. *Labiataæ* is very uniform in the possession of essential oils, several of which are of medicinal value as carminatives and stimulants. Toxic resins are reported from a number of species belonging to *Thymelæaceæ* and animals avoid eating them. Several species of *Euphorbiaceæ* contain highly irritant toxalbumins and are drastic purgatives. Urticating principles are found in four Indian genera of *Urticaceæ*. The alkaloids ephedrine and pseudoephedrine are found in a number of *Ephedras*. *Coniferæ* are characterised by containing essential oils which produce gastro-intestinal irritation and sometimes ulceration. Several species of *Dioscoreaceæ* contain an acrid juice in their tubers and some are even poisonous. Quite a number of species of *Araceæ* contain raphides of calcium oxalate and acrid juices; a number of these plants, if eaten, especially

when in fresh condition, produce symptoms of irritant poisoning. Some of the Gramineæ, especially when young, wilted or under drought conditions produce hydrocyanic acid and are fatal to livestock; no alkaloid has so far been isolated from members of this family.

Many more examples could be cited, but the brief review of the relationship which seems to exist between the botanical classification and the chemical and physiological characteristics of medicinal and poisonous plants should prove sufficient to show that in many of the families and genera these characteristics show a marked degree of correlation. Further work may produce increasing evidence of this relationship. The botanical characters, chemical constituents, and properties exhibited by plants are all the result of organic evolution and a natural classification must embrace all these three aspects. There is, however, an element of disturbance in the case of plants, climate, seasons, soil, cultivation, etc., have profoundly affected their chemical composition and hence their physiological characteristics, and it is for this reason also that closely related plants differ in their pharmacological properties.

XVIII

Newer Trends in Drug Research and its Future: FUNDAMENTAL RESEARCH ON PLANT PRODUCTS.—A brief reference may be made here to the recent work on the place of active principles in the biology of the plant producing them. It is only lately that attention has been paid to this aspect of the study of medicinal plants and as yet little is known on the subject. The group of alkaloids have received more attention in this respect than any other group. James⁴ has recently reviewed the present knowledge and concludes that at least for some plants the alkaloids are formed from the 'soluble nitrogen' pool, which normally consists of amino-acids and amines. These intermediate compounds are removed from the pool to build up proteins and in like manner, the breakdown of proteins results in the return of them to the pool. In alkaloid-producing plants this two-way traffic is partly diverted to alkaloid production and breakdown. Such a theory explains why alkaloids are frequently found in actively growing tissues where protein metabolism is active, and why fertilisers which increase the growth of plant also produce a corresponding increase in the alkaloidal content.

Very similar type of fundamental work is also being carried out with glycosides and also with plant vitamins. The role of the cyanide group, which occurs in several plants containing cyanogenetic glycosides, has also received attention lately because of its possible effect on enzyme systems or in nitrogen metabolism.

⁴James, 1950, *The Alkaloids*, Manske and Holmes, Academic Press, N.Y.

XIX

Future of Research in Indian Indigenous Drugs: * PLEA FOR A NEW ORIENTATION IN DRUG RESEARCH.—It has often been said by learned practitioners of indigenous medicine in this country, that a vegetable drug in fresh condition acts differently to a drug in dried condition which has been kept in storage. If such a view is correct, most of the findings obtained by modern methods of chemical and pharmacological investigations, and clinical trials of these drugs would need re-examination. In the light of our present knowledge it is difficult to appreciate any marked difference between the action of a fresh drug and a crude drug in dried form except perhaps in respect of certain vitamins which particularly occur in green parts of plants used. It cannot probably produce such a vast difference as has been claimed for fresh parts of plants and their juices prescribed by the Vaidas and Hakims. Although such changes are difficult to detect by physical and chemical methods at our disposal, it is nevertheless a very old and interesting belief which should be critically and thoroughly examined. In this connection it may be mentioned that the action of a crude drug such as opium is known to be somewhat different from the action of its individual alkaloids such as morphine for instance. Again a number of crude purgative drugs act differently from their isolated active principles. For example, aloin and sennosides A and B, have different action to that of whole aloes and senna. These and other facts call for a new study of the old empirical methods from this point of view which has not so far been done. "Such evaluation by new standards of modern physiology and biochemistry of both food and drugs (as no distinction is made between food and drugs in ancient medicine) is likely to lead to further interesting results, than have so far been obtained through study of only the active chemical principles of drugs and their pharmaco-therapeutic application. Maintenance of the healthy balance of the normal body processes is just as much a function of medicine (and this aspect was more important in ancient medicine) as drastic curative treatment through introduction of potent foreign substances into the system."⁵ Perhaps the future research workers on these drugs will pay attention to this aspect of the problem of drug action.

FUTURE OF INDIGENOUS DRUG RESEARCH.—It might have been thought that with the discovery of such potent drugs as sulphonamides, arsenicals, synthetic antimalarials and the like, interest in medicinal plant research will decline. It would appear, however, that on the contrary it has acted as a stimulus to work in this field. From the great advances which have been made in the field of synthetic organic remedies during recent years the interest has gradually extended towards natural products both of vegetable and animal origin. This has been more so since the discovery of antibiotics, some of which have actually been synthesised. Indeed there are clearer indications that research on indigenous drugs

⁵In writing this chapter we have taken extensively from 'Indigenous Drugs Research—Present and Future' by B. Mukerji.

of late years has extended even to the Western countries with highly developed chemico-physiological resources for synthesis of therapeutically active compounds. This is due to the fact that it is now becoming increasingly apparent that even though such studies may fail to discover new and potent remedies, the background information regarding the chemical structure and pharmacological action which such work gives may open out the door for creative synthesis. It is undoubtedly true that research in medicinal plants is yielding and will go on yielding much information which is likely to be of use to medicine. We must not forget that gradual shift in medicine from empiricism to rationalism has been chiefly in the methods of evaluating the work of a remedy rather than the methods of discovering new effective one. "The discovery of an effective remedy is still largely empirical and depends on accumulated experience of centuries of trial and error, the chance observation of a trained worker or the lucky emergence of an active compound from a large series of analogues". There are many examples of this in present day drug research. "Modern methods of analysis and synthesis have enormously extended the range of compounds which can be tried but the most important advance is due to modern pharmacological, clinical and statistical methods which have enormously increased our ability to separate the useful drugs from the useless. Advances are being made in correlating the therapeutic effects and physico-chemical-structure but the time still seems to be remote when the physician can ask for a specific remedy and the scientist can then devise a molecule which would fulfill his requirements or indicate a plant species in which such a compound would likely occur". The only methods we have at our disposal to discover an effective remedy even now is by trial and error. "However, the real aim of research work should be to travel the road of advancement which has to be taken by all Natural Sciences, namely, via the cataloguing of numerous, apparently unrelated facts to the formulation of temporary hypotheses, broad principles ultimately to the discovery of natural laws. Synge⁶ has recently stressed the importance of this route by emphasising the need for more fundamental research on the function of cellular constituents in their native organisms; only by this means can we hope to arrive with certainty at real 'cures'."

Fairbairn⁷ in a recent paper has stated, "It would be foolish to ignore vegetable materia medica because the principle of investigation involved still savour of empiricism". India's vegetable materia medica offers a vast field of study and all that has so far been done can be considered to have touched only the fringes of this vast and complex problem. "Modern science and its methodology should be applied with patience and sympathetic understanding to unravel the truth of early teachings, and what appears more important is to clear away the unnecessary mass of foliage from the luscious fruits of ancient medicine".

⁶Synge, 1952, 'Frankland Memorial Lecture', Royal Inst. Chem.; ⁷Fairbairn, J. W., 1953, *Jour. Pharm. Pharmacol.*, 5, 281.

The above brief review of work on the medicinal and poisonous plants, the difficulties encountered and partially overcome, and indications in regard to their utilitarian and scientific aspects, will, there is no doubt, stimulate interest in this subject which is of considerable economic importance to the country, particularly at the present juncture. Collaboration between botanists, chemists, pharmacologists and agriculturists in work of the type indicated in a country such as India, with all extremes of meteorological, climatic and topographical features resulting in very varied and luxuriant floras of all types is pregnant with possibilities which should not only be of very great scientific and academic interest but also prove of great practical importance to the country from the economic point of view.

PART II

THE POTENTIAL DRUG RESOURCES OF INDIA

Pharmacopoeial and Allied Drugs

The drug resources of India are vast and inexhaustible and it can be said without exaggeration that India could supply the whole of the civilised world with medicinal herbs. Leaving aside for the moment the drugs used in the indigenous systems of medicine, whose therapeutic value has been investigated in the majority of cases on scientific lines, most of the drugs of established therapeutic value used in the pharmacopoeias of different countries grow in great abundance and often in a state of nature in many parts of India. Those which are not indigenous can often be grown in many parts. A list of such drugs is given below:—

List of British and Indian Pharmacopoeial Drugs Growing in India

<i>Abroma augusta</i> (I.P.)	....	....	Abroma bark
<i>Acacia arabica</i> (I.P.)	....	....	Indian acacia
<i>Acacia catechu</i> (I.P.)	....	....	Black catechu
<i>Acalypha indica</i> (I.P.)	....	....	Indian acalypha
<i>Aconitum chasmanthum</i> (I.P.)	....	....	Aconite
<i>Adhatoda vasica</i> (I.P.)	....	....	Vasaka
<i>Aegle marmelos</i> (I.P.)	....	....	<i>Bael, Belæ fructus</i>
<i>Allium sativum</i> (I.P.)	....	....	Garlic allium
<i>Aloe barbadensis</i> (B.P. and I.P.)	....	....	Aloes
<i>Alpinia officinarum</i> (I.P.)	....	....	Alpinia, Galangal
<i>Alstonia scholaris</i> (I.P.)	....	....	Alstonia bark, Dita bark
<i>Andrographis paniculata</i> (I.P.)	....	....	Kalmegh
<i>Anethum graveolens</i> (B.P. and I.P.)	....	....	Dill
<i>Anethum sowa</i> (B.P. and I.P.)	....	....	Sowa
<i>Arachis hypogæa</i> (B.P. and I.P.)	....	....	Groundnut
<i>Areca catechu</i> (I.P.)	....	....	Betel nut
<i>Aristolochia indica</i> (I.P.)	....	....	Aristolochia
<i>Artemisia maritima</i> (I.P.)	....	....	Santonin, <i>Artemisia santonica</i>
<i>Astragalus strobiliferus</i> (I.P.)	....	....	Tragacanth
<i>Atropa acuminata</i> (B.P. and I.P.)	....	....	Indian belladonna
<i>Atropa belladonna</i> (B.P. and I.P.)	....	....	Belladonna
<i>Bacopa monniera</i> (I.P.)	....	....	Herpestis
(<i>Herpestis monniera</i>)			
<i>Berberis aristata</i> (I.P.)	....	....	Berberis root
<i>Bærrhaavia repens</i> (I.P.)	....	....	Punarnaba
<i>Brassica integrifolia</i> (I.P.)	....	....	Sinapis
<i>Brassica juncea</i> (I.P.)	....	....	Brown mustard

<i>Butea monosperma</i> (I.P.)	....	....	Butea seed
(<i>Butea frondosa</i>)			
<i>Calatropis procera</i> (I.P.)	....	....	Calatropis
(<i>Calatropis gigantea</i>)			
<i>Camellia sinensis</i> (B.P. and I.P.)	....	....	Tea plant
<i>Cannabis sativa</i> (I.P.)	....	....	Cannabis
<i>Capsicum frutescens</i> (I.P.)	....	....	Capsicum
(<i>Capsicum annum</i>)			
<i>Carica papaya</i> (B.P. and I.P.)	....	....	Papaya
<i>Carum carvi</i> (B.P. and I.P.)	....	....	Caraway
<i>Cassia angustifolia</i> (B.P. and I.P.)	....	....	Senna
<i>Cassia fistula</i> (B.P. and I.P.)	....	....	Cassia fruit
<i>Centella asiatica</i> (I.P.)	....	....	Hydrocotyle
(<i>Hydrocotyle asiatica</i>)			
<i>Cephaelis ipecacuanha</i> (B.P. and I.P.)	....	....	Ipecac
<i>Chenopodium album</i> (I.P.)	....	....	Wormseed
<i>Chenopodium ambrosioides</i> var. <i>anthelminticum</i>			
(B.P. and I.P.)	....	....	American worm seed
<i>Chrysanthemum cinerariæfolium</i> (B.P. and I.P.)	....	....	Pyrethrum
<i>Cinchona ledgeriana</i> , <i>C. succirubra</i> and other			
species and hybrids (B.P. and I.P.)	....	....	Cinchona
<i>Cinnamomum camphora</i> (B.P. and I.P.)	....	....	Camphor
<i>Cinnamomum zeylanicum</i> (B. P. and I.P.)	....	....	Cinnamon
<i>Cissampelos pareira</i> (I.P.)	....	....	Cissampelos
<i>Citrullus colocynthis</i> (B.P. and I.P.)	....	....	Colocynth
<i>Citrus aurantium</i> (B.P. and I.P.)	....	....	Bitter-orange peel
<i>Citrus medica</i> var. <i>limon</i> (I.P.)	....	....	Lemon peel
<i>Claviceps purpurea</i> (B.P. and I.P.)	....	....	Ergot
<i>Cocos nucifera</i> , <i>C. butyraceæ</i>	....	....	Coconut
<i>Coffea arabica</i> (I.P.)	....	....	Coffee plant
<i>Colchicum luteum</i> (I.P.)	....	....	Colchicum corm and seed
<i>Coriandrum sativum</i> (B.P. and I.P.)	....	....	Coriander
<i>Crocus sativa</i> (I.P.)	....	....	Saffron
<i>Cuminum cyminum</i> (I.P.)	....	....	Cumin
<i>Curcuma longa</i> (I.P.)	....	....	Turmeric
<i>Cymbopogon flexuosus</i> (I.P.)	....	....	Lemon grass
(<i>Cymbopogon citratus</i>)			
<i>Datura fastuosa</i> (I.P.)	....	....	Datura
<i>Datura metel</i> (I.P.)	....	....	"
<i>Datura stramonium</i> (B.P. and I.P.)	....	....	"
<i>Derris ferruginæa</i> (I.P.)	....	....	Derris, Tuba root
<i>Digitalis lanata</i> (I.P.)	....	....	Digoxin
<i>Digitalis purpurea</i> (B.P. and I.P.)	....	....	Digitalis leaf
<i>Dryopteris filix-mas</i> (B.P. and I.P.)	....	....	Male fern. <i>Aspidium</i>

PHARMACOPOEIAL AND ALLIED DRUGS

<i>Elettaria cardamomum</i> (B.P. and I.P.)	....	Cardamom fruit
<i>Ephedra gerardiana</i> , <i>E. nebrodensis</i> (I.P.)	....	Ephedra
<i>Erythroxylum coca</i> (B.P. and I.P.)	....	Cocaine
<i>Eucalyptus globulus</i> (B.P. and I.P.)	....	Eucalyptus
<i>Eugenia caryophyllus</i> (B.P. and I.P.)	....	Clove
<i>Eupatorium ayapana</i> (I.P.)	....	Ayapana
<i>Ferula narthex</i> (I.P.)	....	Asafoetida
(<i>Ferula fætida</i>)		
<i>Fœniculum vulgare</i> (B.P. and I.P.)	....	Fennel
<i>Gaultheria fragrantissima</i> (I.P.)	....	Wintergreen
<i>Glycyrrhiza glabra</i> (B.P. and I.P.)	....	Liquorice
<i>Hemidesmus indicus</i> (I.P.)	....	Indian sarsaparilla
<i>Holarrhena antidysenterica</i> (B.P. and I.P.)	....	Kurchi bark
<i>Hydnocarpus kurzii</i> (I.P.)	....	Chaulmoogra
<i>Hydnocarpus wightiana</i> (I.P.)	....	"
<i>Hyoscyamus muticus</i> (B.P. and I.P.)	....	Hyoscyamus
<i>Hyoscyamus niger</i> (B.P. and I.P.)	....	Hyoscyamus leave
<i>Ipomæa hederacea</i> (I.P.)	....	Kaladana
<i>Ipomæa turpethum</i> (I.P.)	....	Turpeth
<i>Juniperus macropoda</i> (I.P.)	....	Juniper
<i>Linum usitatissimum</i> (B.P. and I.P.)	....	Linseed
<i>Lobelia nicotianæfolia</i> (I.P.)	....	Lobelia
<i>Melia azadirachta</i> (I.P.)	....	Nim
<i>Mentha arvensis</i> (I.P.)	....	Peppermint
<i>Mentha piperita</i> (B.P.)		"
<i>Moringa oleifera</i> (<i>M. pterygosperma</i>)	....	Moringa
<i>Myristica fragrans</i> (B.P. and I.P.)	....	Nutmeg
<i>Papaver somniferum</i> (B.P. and I.P.)	....	Opium
<i>Picraena quassioides</i> (I.P.)	....	Quassia
<i>Picrorhiza kurrooa</i> (I.P.)	....	Picrorhiza
<i>Pimpinella anisum</i> (B.P. and I.P.)	....	Anise
<i>Pinus excelsa</i> (I.P.)	....	Colophony
<i>Pinus khasya</i> (I.P.)	....	"
<i>Pinus longifolia</i> (I.P.)	....	"
<i>Piper betle</i> (I.P.)	....	Betel
<i>Piper cubeba</i> (I.P.)	....	Cubeb
<i>Plantago ovata</i> (I.P.)	....	Isabgul
<i>Podophyllum hexandrum</i> (B.P. and I.P.)	....	Indian podophyllum
(<i>Podophyllum emodi</i>)		
<i>Polygala chinensis</i> (I.P.)	....	Indian senega
<i>Prunus amygdalus</i> (B.P.)	....	Almond oil
<i>Psoralea corylifolia</i> (I.P.)	....	Babchi
<i>Pterocarpus marsupium</i> (I.P.)	....	Kino
<i>Rauwolfia serpentina</i> (I.P.)	....	Rauwolfia

<i>Rheum emodi</i> ; <i>R. webbianum</i> (I.P.)	...	Rhubarb
<i>Ricinus communis</i> (B.P. and I.P.)	...	Castor oil
<i>Rosa damascena</i> (B.P.)	....	Rose
<i>Rosmarinus officinalis</i> (B.P.)	....	Rosemary
<i>Santalum album</i> (B.P.)	....	Sandal wood
<i>Saraca indica</i> (I.P.)	....	Asoka bark
<i>Saussurea lappa</i> (I.P.)	....	Saussurea
<i>Sesamum indicum</i> (B.P. and I.P.)	...	Sesame oil
<i>Strophanthus kombé</i> (B.P.)	....	Strophanthus
<i>Strychnos nux-vomica</i> (B.P. and I.P.)	....	Nux vomica
<i>Swertia chirata</i> (I.P.)	....	Chiretta
<i>Terminalia chebula</i> (I.P.)	....	Myrobalam
<i>Thymus vulgaris</i> (B.P. and I.P.)	....	Thyme
<i>Tinospora cordifolia</i> (I.P.)	....	Tinospora
<i>Trachyspermum ammi</i> (B.P. and I.P.)	....	Ajowan
(<i>Carum copticum</i>)		
<i>Tylophora asthmatica</i> (I.P.)	....	Antamul
<i>Urginea indica</i> (I.P.)	....	Indian squill
<i>Valeriana wallichii</i> and other species (I.P.)	....	Valerian
<i>Vernonia anthelmintica</i> (I.P.)	....	Vernonia
<i>Vitex peduncularis</i> (I.P.)	....	Vitex leaf
<i>Withania somnifera</i> (I.P.)	....	Ashwagandha
<i>Zingiber officinale</i> (B.P. and I.P.)	....	Ginger

We will now study the most important of these drugs in some detail.

ACONITUM (Ranunculaceæ)

VERN.—Sans.—*Visha*; Hind.—*Bachnag*; Beng.—*Bisha*;

Bomb.—*Bachnab*; Tam.—*Vashanavi*.

Aconite belongs to a genus of herbs belonging to the family Ranunculaceæ. The word 'aconiton', the classical Greek name, is derived most probably from 'akwan' a dart, from its having been used to poison darts. The root, powdered and formed into a sticky paste with water, was smeared over the arrow heads.

Aconite is one of the oldest remedies used both by the Hindu and Mohammedan physicians in India and is one of the commonest drugs sold by druggists. The so-called 'ferox' variety is still largely used as an external application. The root is formed into a paste (*lep*) and is spread upon the skin as a remedy for neuralgia and other painful affections. Internally it is used in treatment of fever and rheumatism, usually in combination with other drugs; it is also used as a remedy for cough, for asthma and for snake-bite. The Hindu physicians use some varieties of aconite as cardiac stimulants and febrifuge after mitigation. This process of mitigation consists in soaking the roots in cow's urine at ordinary temperature for three days or prolonged boiling with it for as long as 48 hours.

In this manner it is claimed that the root loses its toxic action at the same time retaining the beneficial medicinal properties. The aconite used by Vaidyas as available in the market are mitigated by following the different methods given in the literature of Indigenous medicine. A biological study of these mitigated aconites revealed that the roots have lost their toxic effects but not to the same extent as claimed by the vaidyas. Samples of aconite root mitigated by a number of standard pharmacies in India were studied and in all cases were found to be highly toxic, showing perhaps incomplete mitigation. Mahaskar and Caius have observed that the root loses its depressant action on the heart and become stimulant instead. Soaking in cow's milk gives better result than soaking in cow's urine.

The earliest reference to aconite in the Hindu medicine is about *A. heterophyllum* (ativisha) which is mentioned in works on materia medica by such authors as Chakradatta (A.D. 1050) and Saranghadhara (A.D. 1363). These writers recommended the use of the drug as a remedy in fevers, diarrhoea, dyspepsia and cough, and also as an aphrodisiac. The references to its use in Arabic and Persian works are short and probably originate from these Hindu works. Another variety referred to, *A. palmatum* (bikhma), is intensely bitter like quinine, and in combination with pepper was used internally as a remedy for pains in the bowels, diarrhoea and vomiting, and as an anthelmintic against intestinal worms; externally it was used as an application for rheumatism.

A number of laborious investigations—botanical, chemical and physiological—have been made on the subject of Indian and European varieties of aconite. The researches of Alder Wright, Cash, Dunstan and Stapf. have exhaustively dealt with it. Different workers have adopted different methods of classification according to the plants being poisonous or non-poisonous, annual, biennial, perennial, or according to the structure of their root sections, etc. It, therefore, comes about that many new names have been substituted for the older ones and this has led to a good deal of confusion. When a pharmacist in India has to select a sample for his use, he has to go through the whole literature on the subject, most of which is out of print, in order to identify his sample and get information about it. It should also be remembered that the alkaloids of aconites readily undergo changes in their chemical composition under different conditions of age, temperature, moisture, storage, etc., so much so that sometimes older samples have been found to be seriously deficient in their active principles. One cannot, therefore, rely on roots of questionable age.

Untill recently the Indian aconites had been used in this country in preparations for external applications only. *Aconitum chasmanthum* Stapf. ex Holmes has been now recognised as an Indian substitute for the official *A. napellus* Linn., which is not found in India. From the pharmacological and economic points of view the Indian substitute is more potent and active. The drug is standardised biologically on guinea-pigs. The potency of aconite shall be such that 0.1 gm. of it when extracted and assayed as directed under tincture aconite shall possess an activity equivalent to not less than 0.15 mg. with reference to aconitine. The

author and his co-workers have carefully studied the different varieties of aconite growing in India and have cleared the confusion existing regarding their activity. In order to understand thoroughly the present position regarding the aconites of the Indian market, it will be necessary to go into the classifications that have been adopted for it from time to time.

Indian Aconites of Commerce According to Old Classification

Altogether there are said to be about 180 species growing in the northern temperate zone, but over 50 European varieties and 24 Indian species have been admitted and a number of these have been shown to contain active alkaloids. The members of the genus that grow in India are exclusively confined to alpine and subalpine regions of the Himalayas from Nepal to Kashmir. According to Watt, six species of aconite, recognised by the botanists, grow in India, with two or three varieties under two of these species.

(1) *A. heterophyllum*. VERN.—Sans.—*Ativisha*; Hind.—*Atis*; Beng.—*Ataicha*; Tam.—*Ati-vadayam*; Pers.—*Vajjeturki*. It is well-known to the hill people as being quite inert and it is eaten by them as a vegetable. It grows in the Himalayas at an altitude of 6,000 to 15,000 ft. above the sea-level. The root is commonly employed in indigenous medicine as a mild and bitter tonic and is sold in the bazars under the name of 'Atis' or 'Atees.'

(2) *A. napellus*. VERN.—Sans.—*Visha*; Hind.—*Mithazahar*; Beng.—*Katbish*. Several varieties grow abundantly in the temperate alpine Himalayas at an altitude of 10,000 to 15,000 above the sea-level. Four varieties, *napellus* proper, *A. rigidum*, *A. multifidum* and *A. rotundifolium* are commonly known. Some of these varieties are poisonous and others are non-poisonous. It may be mentioned here that all *A. napellus* sold in the Indian bazars is not the produce of India. Quantities of imported European root also find their way into commerce.

(3) *A. ferox*. VERN.—Sans.—*Visha*; Hind.—*Bish*; Beng.—*Katbish*; Tam.—*Vashanavi*; Guz.—*Vachnag*; Pers.—*Bishnag*; Arab.—*Bish*. Most of the drug used in this country is said to be derived from *A. ferox*, but no exact information is available on this point. This variety was popularly believed to grow abundantly in India, mainly confined to the eastern temperate subalpine regions of the Himalayas eastward of Kumaon at an altitude of 10,000 to 14,000 ft. above the sea-level. It was differentiated from *A. napellus* by its leaves being less divided, its flower racemes being denser and there being a shorter beak to the helmet. *A. ferox* was considered to be undoubtedly poisonous. It was commonly known as the Indian aconite, as most of the root sold in the Indian bazars was believed to be derived from this variety, though undoubtedly it was adulterated with roots from other varieties.

(4) The white spongy root which is exported from northern India is known as Lahore bachnab or Mithazahr. This root is devoid of the peculiar smell of the *A. ferox* root and is probably derived from *A. lycoctonum* which grows abundantly from Kumaon to Kashmir (western Himalayas) at an altitude of 7,000 to 10,000 ft. above the sea-level.

(5) *A. luridum* is found largely in Sikkim. It finds its way into the market and is sold mixed with other varieties.

(6) *A. palmatum* grows in the eastern temperate Himalayas from Garhwal to Manipur, but this species also is not poisonous and is not sold except as an adulterant to active varieties.

In European commerce, all the Indian forms of aconite were classed as forms of *A. ferox*, but it should be remembered that true *A. ferox* is not the most plentiful of the aconite roots in this country and certainly not the most accessible. It thus comes about that the so-called Aconite ferox sold by the druggists is an indiscriminate mixture of the roots of *A. ferox*, *A. lycoctonum*, *A. napellus*, and *A. palmatum*, the latter predominating. That this state of affairs has been going on for many years is evident from the remarks made by Dr. E. R. Squill in the Year-Book of Pharmacy, 1873. He said that although only a few drugs are apparently more cheaply and easily obtained than aconite root, yet perhaps in no other is there so great an amount of uncertainty, many parcels having been found to be comparatively worthless from a medical point of view. Things have, however, improved since then and most of the important active varieties are available in the market, though not without difficulty on account of the tendency to adulteration with cheaper and inactive varieties.

Indian Aconites of Commerce According to New Classification

The Indian aconites remained in a state of confusion so far as their classification is concerned for a long time. Gorris (1901) worked on some of the biennial aconite roots and brought out their distinguishing characters from a study of their transverse sections. Amongst the earlier workers mention may be made of Irmisch (1854) and Meyer (1881) but it was not till 1905 that Stapf cleared the confusion and classified the Indian aconites based on the scientific method of transverse structure of their roots. He divided the Indian aconites into three types. His classification based on root structure and accepted by botanists is given below :—

NAPELLUS TYPE	ANTHORA TYPE	DEINORRHIZUM TYPE
<i>A. soongaricum.</i>	<i>A. rotundifolium.</i>	<i>A. deinorrhizum.</i>
<i>A. chasmanthum.</i>	<i>A. heterophyllum.</i>	<i>A. balfourii.</i>
<i>A. violaceum.</i>	<i>A. navicularc.</i>	
<i>A. falconeri.</i>	<i>A. palmatum.</i>	
<i>A. spicatum.</i>	<i>A. hookeri.</i>	
<i>A. laciniatum.</i>		
<i>A. ferox.</i>		
<i>A. heterophylloides.</i>		
<i>A. leucanthum.</i>		
<i>A. dissectum.</i>		
<i>A. jaduvar.</i>		

Aconites of India Commonly Used in Medicine Along With Their Distribution, Active Principles and Uses

A. balfourii Stapf. VERN.—Darmiya.—*Gobriya*; Nepal.—*Gobari*. This is found in subalpine and alpine Himalayas from Gharwal to Nepal at altitudes of 12,000 to 14,000 ft. above the sea-level. Its roots resemble those of *A. deinorrhizum* Stapf. but are somewhat shorter and thicker with several attached rootlets. Their bitter taste is followed by a tingling sensation in the mouth. It is a poisonous species and is a common constituent of *A. ferox* of commerce. Dunstain and Andrews (1906) showed that daughter tubers contained 1 per cent. of alkaloid pseudoaconitine which was double that of the mother tubers. Recently, the roots have been found to contain 1.2 per cent. of total alkaloids of which pseudoaconitine is 0.4 per cent. (Hewey and Sharp). Pseudoaconitine is highly toxic and biologically 1.5 times as active as aconitine.

A. chasmanthum Stapf. Indian Napellus. VERN.—Kash.—*Banbalnag*, *Mohri*. The plant grows in the western Himalayas at altitudes of 7,000 to 12,000 ft. It is commonly found at high altitudes throughout Kashmir. *A. Chasmanthum* roots are very similar in appearance to *A. napellus* for which it was once mistaken. The tubers of the former are somewhat smaller, shorter and thicker. The mother tubers are deeply grooved and wrinkled, black outside and brown right through. When cut, the fracture is cartilaginous, hard and white within the cambium ring and brownish without. They contain 4.3 per cent. of total alkaloids, i.e., about ten times that of *A. napellus*. The principle alkaloid of the root is indaconitine and its physiological activity is about 9.7 times that of aconitine.

A. deinorrhizum Stapf. VERN.—Bashahr.—*Mohra*; Kash. and Punj.—*Dudhia bish*, *Safed bikh*. The plant is met with throughout the central Himalayas from Kunawar to Nepal and is common in Upper Bushahr in Himachal Pradesh. The surface of the daughter roots is dark brown and coarsely wrinkled, the mother tubers are similar but have longer filiform root fibres. The drug is very hard and horny and its starch is gelatinised during drying. Together with *A. balfourii* it is the principle constituent of *A. ferox* (*vide A. balfourii*) of commerce and is the chief Indian aconite which is now exported to England. Its roots contain 0.9 per cent. of total alkaloids of which pseudoaconitine is 0.4 per cent.

A. ferox Wall. *A. ferox* is a rare and poisonous species found in the northern Himalayas of Nepal and Kashmir. The so-called *A. ferox* of commerce also known as Indian aconite or bish is in fact a mixture mainly of *A. deinorrhizum*, *A. balfourii*, *A. spicatum*, and *A. laciniatum*. *A. ferox* is largely used as an external application. The root is formed into liniment (lep) and applied to the skin in cases of neuralgia and muscular rheumatism. It is also useful as sedative, antipyretic and diaphoretic. A preparation of the root is largely used in all the hilly districts in India as an arrow poison.

A. hetrophyllum Wall. VERN.—Sans.—*Ativisha*; Hind.—*Atis*; Kash.—*Patis*. The plant is common in the subalpine and alpine zones of the Himalayas. It is

extensively exported from the north-west Himalaya into the plains. The roots contain the amorphous non-toxic alkaloid atisine (0.4 per cent.) to which Lawson and Topps (1937) have recently assigned the formula, $C_{22}H_{38}O_2N$. Jacobs and Craig (1942) have further isolated two crystalline alkaloids, viz., heteratisine, $C_{22}H_{38}O_5N$, m.p. 262–267° (decomp.) and hetisine, $C_{20}H_{27}O_8N$, m.p. 253–256° (decomp.). The Central Indigenous Drug Committee in 1901 established its utility as a good bitter tonic but declared it to be worthless as an antiperiodic. This was also confirmed by Chopra *et al.* who observed that its alkaloids possess no antipyretic action. In the Indigenous medicine it is considered a valuable febrifuge and a bitter tonic especially in combating debility after malaria and other fevers. The drug is chiefly used in the form of pure white bitter powder. It is frequently adulterated with insipid and inert tubers of *Asparagus sarmentosus* (satamuli).

A. laciniatum Stapf. VERN.—Sikkim.—*Kalo bikhoma*, *Alpine*. It occurs in the subalpine and alpine Himalayas of Sikkim and adjoining Tibet between 10,000 to 14,000 ft. The roots are somewhat larger than those of *A. spicatum*. This poisonous species is found mixed up in the commercial lots of *A. ferox* and Nepal Aconite.

A. spicatum Stapf. This is the most abundant, robust and characteristic species of aconite occurring in Nepal, Sikkim and Chumbi at altitudes of 10,000 to 12,000 ft. The poisonous nature of the roots is well-known to the people of Sikkim who often muzzle their sheep to prevent them from grazing on it. The roots appear to have been used more as a poison than drug. The roots contain 0.4 per cent. of a new and highly toxic alkaloid named bikhaconitine, $C_{30}H_{51}O_{11}N \cdot H_2O$, m.p. 118–123°. The alkaloid differs from aconitine but resembles pseudoaconitine in its chemical and physiological properties. The roots are sometimes preserved in cow's urine in order to protect them against weevils, but they turn darker externally during storage. The black kind is used for home consumption while the paler one is exported. It is the principle source of the *bikh* or *bish* of the Calcutta market and is sometimes one of the components of *A. ferox*.

A. violaceum Jacq. VERN.—Sutlej Basin.—*Tilia kachang*. It is met with in the alpine zone of the Himalayas from Gilgit to Kumaon at altitudes of 10,000 to 15,000 ft. The roots are whitish to brown with a pure white fracture. The taste is slightly sweetish and is not followed by any tingling sensation. The roots are reported to have been used medicinally and also eaten by hill-men of Kanawar as a pleasant tonic.

STANDARDISATION OF INDIAN ACONITES OF COMMERCE: CHEMICAL ASSAY.—Formerly aconite was standardised by the chemical method as laid down in United States Pharmacopoeia VIII. In U.S.P. IX Revision, the official assay process is also a chemical one with an alternative biological assay method, but the chemical method was accepted as the standard and was generally used. Later it was shown by various workers that considerable variations and inconsistency in the potency of aconite preparations existed, when assayed by chemical and biological methods.

TABLE IV
CHEMICAL ASSAY OF ACONITES ON THE INDIAN MARKET

Name according to old classification	Name according to the classification of Stapf.	Name of the alkaloids isolated	Percentage of total ether-soluble alkaloids	Melting point of alkaloids	Crystalline or non-crystalline	Remarks
<i>Aconitum napellus</i> (Mohri). Specimen 1	<i>A. chasmanthum</i> allied to European <i>A. napellus</i>	Indaconitine	4.50	202-203°	Crystalline	Closely resemble aconitine.
<i>Aconitum napellus</i> Specimen 2	—	—	4.28	—	Do.	..
<i>Aconitum ferox</i>	This specimen was a mixture of <i>A. deionorrhizum</i> and <i>A. balfourii</i>	Pseudaconitine	0.86	211-212°	Do.	Physiological action resembles aconitine but is more powerful.
<i>Aconitum heterophyllum</i>	Belongs to An-thora type of Stapf.	Atisine	0.38	85°	Non-crystalline	—
<i>A. lychnidism</i>	Belongs to perennial type of Stapf. and include <i>A. lychnidism</i>	Lycacacitine (only a minute trace of the alkaloid was obtained)	—	—	—	—

This is due to the fact that, though the various alkaloids present in the root behave similarly to solvents and precipitants, their pharmacological action and toxicity vary considerably. Chemical methods only indicate the total alkaloids, whether active or inactive, whilst aconitine and the allied alkaloids such as jindaconitine and pseudoaconitine are the ones that are responsible for the physiological activity of the drug. For this reason several biological methods of assay were developed.

Table IV shows the total ether-soluble alkaloid contents of the common Indian varieties of aconite roots sold in the bazars. The so called *A. ferox* which has been shown to be a mixture of *A. deinorrhizum* and *A. balfourii* (Stapf.) contains 0.86 per cent. of the total alkaloids. Of the two samples of *A. napellus* (*A. chasmanthum* Stapf.) obtained from two different parts of India, No. 1 contained 4.28 per cent. and No. 2 contained 4.50 per cent. of the total alkaloids respectively. In the European variety of *A. napellus* the total alkaloid content is 0.4 to 0.5 per cent. so that the alkaloidal content in the so-called ferox variety is nearly double and in chasmanthum variety nearly ten times more. The other varieties in the market are *A. heterophyllum* and *A. lycoctonum*; they contain small quantities of alkaloids which are physiologically not very active.

BIOLOGICAL ASSAY.—Aconites are better assayed, not by chemical methods but by biological methods. The guinea-pig method of estimation of the alkaloids consists in finding out the minimum lethal dose of a given specimen to these animals according to their body weight, and comparing it with the quantity of pure crystallised aconitine required for the same purpose as a standard. This method gives a fairly accurate idea of the active principles present in a given specimen. We employed this method for assay of roots of different Indian varieties. It was found that the alkaloids of the so-called ferox variety were about 1.5 times stronger and that of the Indian napellus variety 0.7 times weaker than the aconite of European variety. But the alkaloidal content of the ferox variety is double and Indian napellus (*A. chasmanthum*) 10 times more than that of the European napellus variety.

ACONITES ON INDIAN MARKET.—Out of 24 species of *Aconitum* which occur in India only about 9 species of *Aconitum* roots are commonly found on the Indian market. They are commonly classified by dealers as follows (Dutta, Mukerjee):—

1. True Napellus or European Aconite: These roots are imported from Europe and are genuine roots of *A. Napellus* Linn.
2. Indian Napellus Root: These are generally roots of *A. chasmanthum* Stapf. ex Holmes. It is, however, often adulterated with either *A. heterophyllum* Wall. or *A. palmatum* D. Don or a mixture of both.
3. Ferox Varieties of Aconites: This is commonly a mixture of *A. deinorrhizum*, *A. balfourii*, also adulterated with *A. spicatum* and *A. laciniatum*.
4. White Aconites: Some times a mixture of *A. deinorrhizum* and *A. balfourii* is sold in the market under the name of white aconites.

5. Non-poisonous Aconites: *A. heterophyllum* Wall. is available in the market and is reckoned as non-poisonous.

Chemical assay of these varieties shows that the alkaloid content of the so-called Ferox form (*A. deinorrhizum* and *A. balfourii* combined) is double that of the European variety of *A. napellus* official in the Pharmacopoeia, and that of the Indian *Napellus* variety (*A. chasmanthum*) is ten times as much.

Biological assay of these roots shows that the ether soluble alkaloid (pseudaconitine) of the so-called Ferox form is 1.5 times stronger than aconitine obtained from the European variety of *A. napellus* and the alkaloids obtained from the Indian variety of *napellus* (*A. chasmanthum*) are 0.7 times weaker.

From a comparison of the chemical and biological assays of the different species of aconite that were examined, it can be concluded that both Indian varieties, i.e., *A. chasmanthum* and the so-called *A. ferox*, can be used for the purpose for which aconite roots of the British Pharmacopoeia are used. The other varieties sold in the market have quite different physiological properties and cannot be used. For practical purposes it would appear preferable to bring into use the aconites sold under the name of ferox (the commonest in the market) for the following reasons: (1) They are very common in the bazars and available in large quantities under the name of *bachnab*, *bachnag*, *mithabish*, *mitazahar*, *singyabish* and *dagra*. (2) They can be easily distinguished and their adulteration with any other variety can be easily detected, which is not the case with the *napellus* variety. (3) They are very easily identifiable both by their botanical and chemical characteristics. The tubers are sometimes single or more generally 2-3 fasciculated, fusiform 2-5" long, $\frac{3}{4}$ -1" in diameter (at the thickest portion), dark brown or nearly black externally. (4) The outer cuticle is thick and prevents to some extent the access of moisture. They do not deteriorate rapidly, and have a fairly constant composition owing probably to their being of a uniform variety. (5) The alkaloid can be very easily crystallised, about 80 per cent. being crystallisable, so much so that from an assay sample of about 10 gm. of the root pure crystals are obtainable for identification.

Aconitine is a cardiac irritant alkaloid, which in the form of tincture, when applied locally acts as a peripheral stimulant to sensory nerves, producing first a tingling sensation and then depression and numbness. Taken internally, it stimulates the vagus centre and slows the heart rate. It is used as a cardiac depressant in high arterial tension of cardiac origin.

No reliable figures about the trade in the roots exist. Datta estimates that from the three main sources, viz. (i) the north-west Himalayas from Kashmir to Hazara, exporting *A. chasmanthum* and *A. heterophyllum* (mainly to Amritsar); (ii) the central Himalayas, exporting *A. deinorrhizum* and *A. balfourii*; (iii) and the eastern Himalayas exporting 'Nepal Aconite' (*A. spicatum* and *A. laciniatum*) chiefly to Calcutta. At least 1,000 cwt. of aconites are brought down annually into the plains. Besides consumption within the country, some quantity is also exported from Calcutta and Karachi. With the exception of *A. heterophyllum*

all the well-known species have been exported from time to time, and indiscriminately called *A. ferox* in the foreign market. Indian aconite now imported into England is usually derived from *A. deinorrhizum*. Another variety guaranteed to be *A. napellus* (*A. Chasmanthum*) has also been imported since 1938 (Trease).

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ALOE VERA Tourn. ex Linn. (Liliaceæ)

Syn. *Aloe barbadensis*

VERN.—Saus. and Beng.—*Ghrita-kumari*; Arab.—*Sabbara*; Pers.—*Darakhte-sibr*; Hind.—*Ghec-kunwar*, *Musabbar*; Mar.—*Korphan*; Guj.—*Kumarpathu*; Tam.—*Chirukattali*; Tel.—*Chinna-kata banda*; Kan.—*Loli-sara*; Mal.—*Kumari*.

The uses of aloes, the common musabbar, for external application on inflamed painful parts of the body and for causing purgation are too well-known in India to need any special comment. Its application in medicine dates back to the fourth century B. C. Aloes is a genus of 160 species of xerophytic plants indigenous to East and South Africa. Several species have been introduced into India, the East and West Indies and other tropical countries and also Europe. Aloes flourishes in a variety of climates and on the poorest soil. The plants have large fleshy leaves from which a thick juice flows when they are detached by means of transverse cuts. The juice is allowed to drain into suitable vessels and then concentrated by evaporation, sometimes spontaneously but more frequently by boiling. The juice is colourless to start with but darkens, due to evaporation and boiling, and hence the commercial drug is met with in dark hard masses.

A. vera Linn. (*A. vulgaris* Lam., *A. barbadensis* Mill., and *A. officinalis* Forsk.) is a native of north Africa but it has spread into East and West Indies, India, China and other countries. Many of the forms of this species are naturalised in India and are found in a semi-wild state in all parts from the dry westward valleys of the Himalayas upto Cape Comorin. The plant is generally propagated by suckers. There are 2 to 3 easily recognisable varieties in India but their exact delimitations are not clear. *A. vera* var. *chinensis* Baker is common all over the Deccan and Madhya Pradesh. *A. vera* var. *littoralis* Koenig ex Baker is found on the beach shingles in Madras right upto Rameswaram. Another variety

which thrives on the Kathiawar coast is the source of Jaffarabad aloes. This has also been called *A. abyssinica* by some authors. *A. variegata* Linn. a near ally of *A. vera* is found in parts of Bombay. Although the drug yielded by the Indian plant seems to be in no way inferior, *A. succotrina* is most highly esteemed, figures most in the trade returns, and is imported into Bombay via Zanzibar and direct from the Red Sea ports. It is usually sent from these parts packed in skins, the packages varying much in size and shape. In Bombay, the skins are opened and aloes repacked uniformly in boxes for export to Europe and Straits Settlements. This included locally produced aloes from Madras and Mysore. There is, however, no export trade now. The quantity imported from South Africa and Germany has gradually declined. In the quinquennium ending 1929-34 the average annual imports were 1,016 cwt., valued at Rs. 25,903, and in the following quinquennium 454 cwt., valued at Rs. 11,245; in 1939-44, annual imports were only 57 cwt. valued at Rs. 2,717.

Although aloes does not grow largely in a state of nature, the cultivation of the plant is easy and as it flourishes in the driest and poorest of soils, it could be easily produced in India.

CHEMICAL COMPOSITION.—The active constituent of aloes is a mixture of glycosides called 'aloin'. The proportion of 'aloin' varies in different specimens of aloes in the market. The principal constituent of 'aloin' is barbaloin which is pale-yellow crystalline glycoside soluble in water. Among other constituents mention may be made of isobarbaloin, β -barbaloin, aloce-emodin (a hydrolytic product of barbaloin), resins and some water-soluble substances. The odour is due to traces of an essential oil. The B. P. limits the ash content to 5 per cent. and the loss on drying at 100° (moisture, etc.) to not more than 10 per cent. The physical nature of aloes depends upon the species from which it is prepared and the manner in which the juice is concentrated. If the juice is dried in the sun or concentrated over a low fire it gives an amorphous, opaque, waxy extract called hepatic or livery aloes. But if the juice is concentrated rapidly over a strong fire, the material obtained on cooling is amorphous and semi-transparent and is called 'glassy' or 'vitreous' aloes.

Chopra and Ghosh (1938) examined the juice of *A. vera* var. *officinalis* and found that it contained no aloin, but only some resin and gum with small quantities of anthraquinone derivatives such as emodin and chrysophanic acid. Jaffarabad aloes has been reported to contain 13.6 per cent. of aloin without any isobarbaloin (Wehmer, I, 150). Aloes has a bitter disagreeable taste and is largely used as a cathartic and is valuable in the treatment of constipation but is not suitable for use in pregnancy. It produces pronounced pelvic congestion and is used for utrine disorders generally with preparations of iron and carminatives. Aloes forms one of the constituents of several proprietary laxative preparations.

USE IN INDIGENOUS SYSTEM.—In Indian medicine also aloes (musabbar) is used as stomachic, purgative and emmenagogue. It is regarded as valuable in

the treatment of piles and rectal fissures. The mucilage is cooling and is used as a poultice for application on inflamed parts. Jaffarabad aloes is used in lacquer work also.

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ARACHIS HYPOGÆA Linn. (Leguminosæ)

GROUNDNUT, PEANUT, MONKEY NUT

VERN.—Sans.—*Buchanaka*; Hind.—*Mung-phali*; Beng.—*China-badam*; Mar.—*Bhui mug*; Tel.—*Verusenagalu kaya*; Tam.—*Verkadalai*; Kan.—*Nela-gadale*; Mal.—*Nelakadala*.

The plant *A. hypogæa* is originally a native of Brazil but it is now cultivated in all tropical or sub-tropical countries. The major groundnut producing countries are India, China, U.S.A. and West Africa. It is also cultivated in Burma, the East Indies, Nigeria and in southern Europe. The plant is reported to have been introduced into India in the sixteenth century. Its cultivation extended at a phenomenal rate from 1900 onwards and today India is the largest producer of groundnuts accounting for more than 35 per cent. of world production. In India, Madras, Bombay and Hyderabad are the major groundnut producing states. Its cultivation has now extended to Madhya Pradesh, Uttar Pradesh, and northern India also.

The seeds of this plant besides being extensively employed as food-stuff yield on expression 40 to 50 per cent. of a clear oil with a very mild agreeable taste. It is a rich source of fat, protein and vitamins, B₁, B₂, nicotinic acid, and vitamin E. Pickett (1942) and Sarma (1944) have also reported the occurrence of vitamin B₆ (pyridoxine). The red skins are particularly rich in vitamin B₁ which is lost usually in processing. The nuts are comparatively poor in vitamin A and vitamin C. They are a good source of lecithin about 0.5–0.7 per cent. of the decorticated nuts (Traill, 1945). In America groundnuts are known as peanut and are very popular and are used for out-of-hand eating, confectionery and peanut butter, and in the form of peanut flour. Owing to the high fat and protein content groundnuts form a valuable energy giving food. The production of groundnut oil in India has increased very considerably in recent years, where it is utilised for the manufacture of vanaspati or vegetable ghee by hydrogenation. The consumption of the oil in this country has risen from about 44,000 tons in 1938 to over 1,63,000 tons in 1945. Oil of pharmaceutical quality is obtained from the seeds by cold expression. It is pale yellow in colour and has a fatty odour and bland taste. Its properties are similar to those of olive oil. It clearly resembles olive oil both as regards taste and other physical and chemical

properties. A comparison of the constants of the two oils will reveal this similarity in a striking manner:—

	<i>Groundnut Oil</i>	<i>Olive Oil</i>
Sp. gr. at 15°C.	0.9165 to 0.9175	0.916 to 0.918
Solidifying point	0 to 2°C.	3 to 4°C.
Refractive index at 15°C.	1.4731	1.4698 to 1.4703
Saponification value	185.6 to 196	185 to 196
Iodine value	83.3 to 105	79 to 88 usually

Arachis oil contains palmitic, stearic, arachidic, behenic, lignoceric, oleic and linoleic acid components and it is greatly esteemed for domestic purposes as it does not become so rancid as other oils. The oil is also regarded in India as an aperient and emollient.

Olive oil is largely employed in medicine, both externally and internally. It is a basis for liniments and ointments. It is also a nutrient and a food and can be given in wasting diseases. Arachis oil satisfies almost all the properties possessed by olive oil so that it can be used as a substitute for it, particularly in India, where arachis oil is available in large quantities at a very cheap price in contradistinction to olive oil which is very expensive. The substitution of arachis oil for olive oil is actually carried on in commerce to a very large extent. Most of the specimens of 'pure lucca olive oil' from France and Italy are not true olive oils but arachis oil purified and passed on as olive oil. The B. P. recommends its use as substitute for olive oil in making ointments, liniments, plasters, and soaps; also in official preparations as a vehicle for solutions of vitamin A and D. The oil after proper sterilisation may be used as a vehicle for oily preparations used for making injectibles. It is used for feeding children, in the form of emulsion. In veterinary medicine it is used as nutritive, laxative and emollient. It is also employed in the form of emulsion for the control of several insect pests of plants. The toxicity of insecticides such as derris or nicotine is increased in this way. Usually lower grades of oil are used in the manufacture of soap, cosmetics, leather dressing, substitutes for tallow and Diesel oil.

GROUNDNUT CAKE.—After expressing the oil the residue or the groundnut cake is one of the cheapest oil cakes and has high nutritive value and constitutes a very valuable concentrated feeding stuff for cattle and other farm animals. It contains a higher percentage of proteins than any other oil cakes. Groundnut cake is a good organic nitrogenous manure particularly for paddy, sugarcane, coffee and tea. In combination with superphosphates and potash it has been found very beneficial in areca-nut cultivation.

The export of groundnut in the form of kernels, oil and oil-cakes has been increasing since the beginning of twentieth century. U. K., Ceylon, Germany, Netherland, Belgium and other countries import large quantities mostly through Madras and Bombay ports. Export figures from Indian ports during 1945-46 were 1,97,000 tons, and during 1946-47 were 1,17,000 tons (under control). The bulk of exports from India is in the form of kernels. The groundnut oil is also exported in considerable quantities but its export is insignificant as compared

with the production of oil in India (7.5 per cent. of production during the quinquennium ending 1937-38). The annual exports of groundnut oil from India are shown below:—

	Quantity in Tons	Value in Lakhs of Rupees
1932-33/36-37	3,379	11.67
37-38	12,206	43.19
38-39	18,151	57.64
39-40	16,409	52.37
40-41	35,934	128.95
41-42	26,449	93.60
42-43	8,664	42.76
43-44	685	5.07
44-45	664	9.00

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ARTEMISIA MARITIMA Linn. (Compositæ)

WORMSEED; SANTONICA

VERN.—Hind.—*Kirmálá*; Bomb.—*Kiramaniowa*; Pers.—*Shih, Dirmanah, Sarigun*; Arab.—*Afsantin-ul-bahr; Shik*.

The plant artemisia is a very ancient remedy and was extensively used by the Greeks and Romans to expel intestinal worms and as a stomachic. The old Arabian and Persian physicians used it for the same purpose and it was probably introduced into India by them, as no mention of this drug can be found in the old Ayurvedic writings. The flowering tops have been and are to this day largely used in the Tibbi (Mohammedan medicine) in India as an anthelmintic. Usually they are powdered and are given in 2 to 4 dr. doses. The drug is also used as a remedy for dropsy. A decoction made from the plant, which would consist mainly of the essential oil, is used as a cardiac and respiratory stimulant. *A. maritima* Linn. (*A. brevifolia* Wall.) grows abundantly in the high altitudes of the Himalayas from Kumaon to Kashmir at a height of 4,000 to 12,000 ft. It is said to grow more abundantly and uniformly in Beluchistan, Chitral and Afghanistan than in the Himalayas. It grows in such abundance in the last-named country that it is used as a packing material for fruit which is imported from Kandahar. In spite of this abundant supply, santonin was not manufactured in India either for internal consumption or export till recently.

Before the World War I, practically all the santonin on the Indian market was of Russian origin and was imported from Europe. It was obtained from

A. cina Berg., but there are many allied species, such as *A. maritima* var. *stechmanniana* Besser (*A. lerehiana* Karel and Kiril), *A. pauciflora* Stechm (*A. maritima*), etc., which are indigenous to the vast uncultivated plains of the Kirghiz in Turkestan. A number of species of artemisia are also widely distributed over different parts of Europe, Asia and America. Formerly large quantities of the strongly-aromatic flower heads were collected and sent to the European markets, especially to Moscow and Petrograd, some also found their way to India via Afghanistan and Persia. Factories were later established in some of the large towns in Turkestan where santonin is extracted, and mainly the purified product is now exported. Some years ago there was a great scarcity of santonin, owing to the wasteful and destructive methods of collection, and to the political and economic upheaval in Russia. Efforts were, therefore, made to find other sources of the drug with a view to increasing its output. The plant, however, is found only in a restricted area in Russian Turkestan and attempts at the extension of cultivation have hitherto failed. Extensive investigations have also been carried out from time to time on other plants of the same genus, as additional or alternative sources of santonin. In Holland, Van Laren has successfully cultivated *A. cina*, which has yielded as much as 1.3 per cent. of santonin. Some of the American species of artemisia growing in Mexico and the neighbouring states have also yielded santonin. *A. gallica* grown in France was found by Heckel and Schlagdenhauffen to contain santonin, although the percentage was not stated by them. An examination by Maplethorpe in 1924 of *A. gallica* and *A. maritima* found in the south of England led to the conclusion that the English variety of these plants contained very little or practically no santonin. Despite the large amount of work done on various species of artemisia, it has not yet been possible to find a variety which contains a workable percentage of santonin and which can stand comparison with the Russian variety.

INDIAN SPECIES OF ARTEMISIA.—Many species of artemisia grow in the Himalayas but *A. brevifolia* Wall. (*A. maritima*) contains santonin. This is a shrubby aromatic plant about 3½ ft. high with a woody root-stock; erect or ascending stems and much branched from the base. It is an exceedingly variable plant with erect or drooping flower heads. It is found in the western Himalayas from Kashmir to Kumaon at an altitude of 7,000 to 9,000 ft. This is the only santonin-bearing species occurring in India. This species is common in several areas of north-western India such as Kashmir, Kurram, Kagan, Bushaher, Waziristan, Chumba, etc. Plants occurring in some parts of Kashmir and Kurram only however contain workable percentage of santonin. In these areas santonin-free plants are also growing. Badhwar (1934) observed that in the earlier stages of growth santonin-bearing plants in the Kurram valley have red stems while santonin-free plants have green stems and that both turn brown as they grow older. He has called the former *A. maritima* forma *rubricaulis* Badh. Qazilbash has studied somewhat in details the extent of santonin-bearing artemisia occurring in the Kurram valley. He has come to the conclusion that there occurs another species named *A. kurrumensis* Qazil. which grows more commonly and

contains more santonin. After partition of India most of the good area growing santonin-yielding artemisia, i.e. Kurram valley, was lost to the Indian Union. The areas of Rattu and Astore in the frontier districts of Kashmir State used to supply most of the artemisia required by the santonin factory at Baramulla (Kashmir), but these areas too came under the occupation of Pakistan after the political disturbances of 1947. The Gurez area remaining in Kashmir does not yield sufficient quantity of the drug to meet country's demand in India. With a view to discover other sources for supply of this important drug, a survey of the areas growing artemisia was carried out in Jammu and Kashmir State, Himachal Pradesh, Kangra-Kulu valley, and in Kumaon hills in U. P. As a result of this extensive survey it was observed that *A. maritima* containing 1.2 per cent. santonin grows wild in Dhool Dhar of Chenab valley in Jammu and Kashmir State. Before 1947 the Chenab valley was unknown for its artemisia. The supply from this source is limited at present but there is scope for artificial propagation of this plant. The factory at Baramulla is making use of this artemisia since partition.

The area, under artemisia in Kurram first discovered was estimated by the Botanical Survey Department to be roughly 200 acres of fairly thick crop, but there are many similar areas in the adjacent hills and there is a larger tract of more than 2,000 acres, with a crop of varying density scattered over it. Several closely related species of artemisia have been collected from this locality. *A. maritima* is found in most parts of this valley and is known by the name 'spirah tarklah' and this is the variety which bears santonin. The other species such as *A. salsoloides*, *A. absinthium*, *A. campestris* and *A. vulgaris*, which were collected showed no santonin whatsoever.

The position of santonin production in India is quite different after the partition of India in 1947. The only factory manufacturing santonin in Kashmir State has not enough raw material to work to its full capacity. Handa, Kapoor and Chopra (1953) reported that they could not detect any appreciable quantity of santonin in samples of artemisia obtained from Himachal Pradesh, Kangra and Kulu valleys. Santonin contents of 0.65 and 0.68 per cent. were detected in the samples of artemisia collected in July from Malari (Kumaon Hills). This gives an indication that if an extensive survey of the various areas in U. P. where artemisia grows, is undertaken, it is likely some workable quantities of the santonin-yielding drug may be obtained or if better strains of artemisia plant are introduced in this area, the cultivation may be successful.

Santonin Content of Indian Artemisia

The active principles of *A. maritima* consist of: (1) a volatile oil which has an odour resembling cajuput oil and camphor; (2) santonin and an allied body artemisin.

The amount of santonin extracted from the Russian artemisia usually is 1.2 to 1.4 per cent., but may be as high as 2.3 to 3.6 per cent. It appears from several analyses made by Dr. Greenish, Dr. Simonsen and the chemists of the Imperial Forest Research Institute, that as much as 1.95 per cent. of santonin may be obtained from flower buds and leaves. Later estimations, however, have proved that the yield from the Kashmir artemisia is lower still

and seldom goes beyond 0.5 per cent. This is partly due to the fact that the santonin content of *A. maritima* from these regions is naturally somewhat low, and unless it is collected at the proper time, the yield is still further reduced. It has been shown that the plants collected in June from Kashmir (Gurez) have no santonin at all; those collected in July and August showed from 0.1 per cent. to 0.9 per cent., the latter being the maximum yield. In the first half of September, the santonin content again falls to 0.1 per cent. and after that, it is entirely absent, or only traces are present. The method of extraction of santonin followed by the chemists in India is said to be responsible to a certain extent for the low yield. In the factories of Russia, santonin is extracted by a new and improved method said to be devised by Dr. Ferdinand Krauss of Braunschweig. This method allows nearly 98 per cent. of the santonin content to be extracted from the flower buds of the plants, whereas in India, only 70 to 80 per cent. of the santonin is made available. If the former method is used, the yield could be increased by cutting down the waste which is at present sustained in the process of extraction.

The method of collection of the plant has also been defective. In old days, the whole plant was cut off from the root and the flowering tops, the leaves and the stalks were all mixed together. As the woody stalks contain little or no santonin, this process further helped to reduce the percentage. The method now employed is to strip off the leaves and flower-buds directly from the plant by hand and then dry them in the sun. This method is less wasteful, as the plants from which the leaves and flower-buds are stripped off, do very well. Not only is their future growth and development not hindered, but they bear fresh leaves. The cutting off of the whole plant is not only harmful from point of view of future growth, but is also expensive both for labour and transport. A comparative examination of the physical and chemical properties of the Indian santonin shows that it practically comes up to the Russian santonin. A perusal of the following statements will make this point clear:—

<i>Imported Russian Santonin</i> (Standard)	<i>Indian Santonin</i> (Smith Stanistreet Brand)
1. Very sparingly soluble in cold water. Soluble in 40 parts of cold rectified spirit, in 3 parts at the boiling point and in 4 parts of chloroform	Same as the standard.
2. Crystallises in flattened columns, in feathery radiating groups or in flaky plates. Odourless, tasteless at first but afterwards develops a bitter taste. The cold alcoholic solution has an extremely bitter taste	Do.
3. When heated becomes reddish brown, evolves white fumes and on cooling sets to a clear brown vitreous mass, which is reddened on treatment with a little dry alkali or slaked lime	Do.
4. On exposure to light, especially to direct sunlight, santonin acquires a yellow colour. The hot alcoholic solution of this altered substance is yellow, but deposits crystals of colourless santonin on cooling	Do.
5. Laevo-rotatory in chloroform— 171.4°	Laevo-rotatory in chloroform— 161.2°
6. Specific gravity 1.1866	Same as the standard.
7. Melts at 171° to 172°C .	Softens at 169° and melts completely at 171°C .
8. Leaves no appreciable ash	No appreciable ash.

The slight differences noticed are probably due to traces of impurities. The pharmacological action and toxicity of the Indian variety also correspond to those of the variety imported from Europe. A series of cats, whose stools were previously examined and found to contain ova of belascaris and hookworm, were given the drug in doses ranging from 45 to 80 mg. The belascaris were expelled and the ova disappeared from the stools. No toxic symptoms were produced in these animals.

The therapeutic efficacy of the drug was tested by clinical trials in a large number of cases in the Carmichael Hospital for Tropical Diseases and in the Alipore Central Jail. Indian santonin was given combined with calomel and sodium bicarbonate. The results with Indian santonin compared favourably with those ordinarily obtained with European santonin. It was found to be more effective on ascaris than chenopodium. Recent studies by Dr. Maplestone have shown that a combination of santonin and chenopodium is very much more effective in the treatment of ascaris than either of these drugs alone.

The workable percentage of santonin should be not less than 1.2 per cent. in the plant for commercial exploitation. Indian artemisia is generally poorer in santonin than Russian species (*A. cina*) from Turkistan which is reported to contain 2.3–3.6 per cent. The santonin content of Kashmir drug has been reported by several workers to vary from 1–2 per cent. (Krishna and Verma) and that of artemisia from Kurram valley from 1–1.6 per cent. (Badhwar). Baldwin has isolated from the Indian plant in addition to santonin two more crystalline constituents; santonin of much weaker anthelmintic action and pseudo santonin which is devoid of anthelmintic properties. Artemisin is another bitter principle reported to occur in *A. maritima*. All the varieties of *A. maritima* contain essential oils which vary both in quantity (2–3 per cent.) and in composition. The commercial oil a by-product of santonin factories is a thick yellow oil. The essential oil from Turkistan variety has been found to contain cineole 27.8, and thujone 7–8 per cent. *A. maritima* var. *kazakewicz* yields an oil (0.6 per cent.) which contains 36 per cent. of camphor. The quantity of artemisia which could be collected before the disturbances in 1947 in Kashmir was estimated at over 180 tons per annum but the output is much less since then.

CULTIVATION.—Efforts have been made to grow artemisia rich in santonin in upper Kurram. The plants raised from seeds or root appeared to flourish well. The area under cultivation has been greatly extended in Kurram valley. Attempts are being made to propagate the santonin yielding variety of artemisia in Kashmir, Himachal, Chakrata (U. P.), etc. It is observed that the plant can be easily propagated by seeds or root division. The plant puts up a good vegetative growth in the second year of its cultivation but the santonin contents are rather low in the first few years.

Seeds of *A. maritima* from Japan and *A. cina* from Russian Turkistan have been obtained and propagated by the authors in Kashmir. *A. cina* seeds did not germinate. Analytical results of the cultivated samples are as follows:—

<i>Nursery</i>		<i>Age of Plant</i>	<i>Santonin Content</i>
(1) Baramulla	5,500 ft. above sea-level	.... 1 year	0.35 per cent.
(2) Srinagar	5,000 ft.	.... 1 "	0.31 " "
(3) Srinagar	" " ....	.... 2 "	0.47 " "
(4) Simla	7,000 ft. ....	.... 2 "	0.61 " "
(5) Yarikhah	7,000 ft. ....	....
(Chenab-valley seeds)		1 "	0.45 " "
(6) Yarikhah	" " ....	....
(Japan seed).		1 "	0.39 " "

The results obtained from cultivated samples are not upto standard but it is hoped that with improved methods of cultivation and with the maturity of the plant the santonin contents may increase.

Artemisia are xerophytic plants. They grow in semidesert areas in central Asia where extremes of temperatures both high and low prevail. The plants prefer saline sandy soil. Analysis of the soil in Kurram showed that it has high available potash content and is rich in salt and fine sand. A semi-arid climate and a saline sandy soil appear to be best suited for its cultivation. A study of seasonal variation of santonin in Kurram *artemisia* showed that upto about second week of June santonin is concentrated only in leaves and reaches a maximum between the end of May to the end of June, when buds begin to appear. Thereafter santonin passes into buds and reaches its maximum when they are fully developed, just before they open—between 10th August and 10th of September. With the opening of bud there is rapid fall in santonin content. Handa, Kapoor and Chopra (1953) observed that time of flowering of *artemisia* varies in different areas. In Sindh valley the plant flowers in July while in the inner dry regions of Chenab valley the plant flowers late in November. In Garwal the flowering time of *artemisia* is September.

ECONOMIC POSSIBILITIES.—Santonin is one of the most expensive drugs in the Pharmacopoeia, its current price being Rs. 200-300 per lb. During the World Wars and for some time after it was selling at Rs. 700 per lb, a single dose of 3 gr. costing nearly a rupee. For mass treatment in a poor country like India, it is essential that some source should be found from which santonin could be obtained at a cheap price. Russia still holds the monopoly of production and trade in santonin. A limited quantity of it is being produced in India by Kashmir Pharmaceutical Works in Baramulla, Kashmir. It used to produce 2,200 lb. of santonin per year but now due to availability of less *artemisia* the production has fallen. The total consumption in India is estimated at 1,000-1,200 lb. per year and in 1945 the price per oz. was Rs. 14 to 16. The level of price is maintained by an international pool system. Santonin of Indian origin has been shown to be therapeutically as effective as that of Russian origin.

The incidence of ascaris and oxyuris infections amongst the population of this country is very heavy indeed. This will be seen from an estimate by the Helminthological Department of the Calcutta School of Tropical Medicine and Hygiene. Over 65 per cent. of the population seems to be affected in Burma, Assam, Orissa and parts of Madras, where the rainfall is heavy and the surface water abundant during the monsoon season. In Bengal and parts of Bombay the incidence is from 35 to 50 per cent. and in the Uttar Pradesh, it varies from 15 to 25 per cent. In the drier parts of India like the Punjab and Rajputana, though the incidence is less than in the parts mentioned above, it is in no way insignificant. The huge demand for santonin can, therefore, be easily appreciated. Under the circumstances, the development of the santonin industry will be beneficial to all concerned.

A. absinthium Linn. Wormwood. VERN.—Arab. and Pers.—*Afsanthin*. This is an aromatic and bitter herb found in Kashmir at altitudes of 5,000–7,000 ft. The essential oil of *A. absinthium* (about 0.3 per cent.) used to be the constituent of 'absinthe' but because it produces addiction its use has been prohibited. The commercial oil is produced in America and its chief constituents are thujone and thujyl alcohol (Finnemore 844). Wormwood oil has a tonic stimulating effect on the digestive organs and is sometimes used externally. The plant also contains a bitter glycoside, absinthin and a crystalline compound. The dried leaves and flowering tops of the plant have medicinal properties. Its tincture (B. P. C.) is used as a tonic and digestive. Besides, there are other species of artemisia growing wild in India some of which may be briefly described.

A. dracunculus Linn. This is a perennial herb found in western Tibet (14,000–16,000 ft.) and in Lahul. The herb contains about 0.3 per cent of essential oil which has an anise-like odour. The leaves and its essential oil are used for flavouring vinegar and as a spice. It is cultivated in France for its essential oil known as oil of taragon.

A. pallens Wall. ex DC. VERN.—Mar., Tam. and Kan.—*Davana*. It is an aromatic annual found in certain parts of south India especially in the Mysore State. It is also cultivated in the neighbourhood of Poona. Its fragrant leaves are used in floral decorations. The yield of oil has been found to be 0.22–0.58 per cent. The oil is very popular in Perfumery Trade in America where it used to be sold at Rs. 350–400 per lb. (1940–41). The plant is cultivated on a limited scale near Mysore City.

A. sacrorum Ledeb. This species occurs in western Tibet, Kunawar and in the Tibetan regions of Kumaon (10,000–12,000 ft.). It is said to be given to horses for affection of the head. The plant yields 1 per cent. of an essential oil, which contains cineole (19.26 per cent.) and camphor (6 per cent.) etc.

A. siversonia Ehrh. ex Willd. This is an annual herb similar to *A. absinthium*, distributed in western Himalayas from Kashmir to Lahul (8,000–10,000 ft.) and

in western Tibet. It is reported to be of medicinal value and also is a good fodder. The composition of milk is not affected even when it constitutes about 40 per cent. of animal fodder. It contains protein 15.5 per cent. and fat 5.12 per cent., with digestive coefficient of 62.2 and 71.4 per cent. respectively.

A. vulgaris Linn. Indian Wormwood. VERN.—Hind. and Beng.—*Nagdona*; Mar.—*Dhordavana*; Tam.—*Machipatri*; Kash.—*Tithwan*. It is a tall aromatic shrub found throughout the mountainous districts of India ascending to an altitude of 12,000 ft. in western Himalayas and to 5,000 to 8,000 ft. in Sikkim, the Khasia, Ava and Martaban mountains. It grows at Mount Abu in Marwar and on the Western Ghats. In Indian medicine the leaves and flowering tops are administered in the form of an infusion in cases of nervous and spasmodic affections. It is also said to be antiseptic, expectorant and anthelmintic. The plant yields about 0.2 per cent. of a volatile oil. This oil has been found to be a good larvicide for mosquitoes in the same way as kerosene, although it is only a feeble insecticide.

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ATROPA ACUMINATA Royle (Solanaceæ)

DEADLY NIGHT SHADE, BELLADONNA, INDIAN. BELLADONNA

VERN.—Beng.—*Yebruj*; Bomb.—*Girbuli*; Hind.—*Sagangur*, *Angurshefa*, *Lukmuna*; Kash.—*Maitbrand*, *Jalakafal*; Punj.—*Suchi*, *Angurshefa*.

The genus *Atropa* comprises of 4 species of medicinal plants distributed in the Mediterranean region, southern Europe and Asia. *A. belladonna* Linn. amongst these has long been a reputed drug in Europe but the species found wild in India is *A. acuminata* (Indian belladonna). There was some confusion for many years about the correct botanical name of this plant. It was reported as *A. belladonna* in Flora of British India but tracing back its exact taxonomic history to the middle of eighteenth century it is now named *A. acuminata*. Royle ex Lindley. It has been further suggested that it may be named *A. belladonna* Linn. var. *acuminata* due to its clear affinity in morphological, anatomical and chemical characters with *A. belladonna*.

The plant is an erect, tall, perennial, bushy herb, 2-5 ft. in height, with dichotomously branched system. The leaves are oblong elliptical, tapering

gradually at both the apex and the base. On the flowering branches the leaves occur in pairs. The leaves are green or olive green in colour. They vary in length between 3 and 8 in. and in breadth from 1.5 to 2.5 in. The flowers are axillary, dirty yellow, drooping and campanulate, occurring solitary or in groups of two or four. The plant flowers in June–August. The fruit is a globular berry and looks like a cherry when ripe in October. The root stock is hard and woody from 1 to 2 in. width. The roots get wrinkled longit^r finally on drying and the fracture is tough.

Belladonna and its alkaloid atropine are largely used in Western medicine as a sedative, antispasmodic and mydriatic in diseases of the eye. It is a valuable antidote in poisoning by opium, muscarine, etc. Belladonna is a highly toxic drug. Tincture belladonna is standardised to contain 0.03 per cent. of alkaloids, and is administered in doses of 5–30 min. Doses larger than these are toxic. The immediate effects of belladonna poisoning are dryness of mouth, throat and skin, dilatation of pupils and giddiness. These are followed by a failure of the respiratory system, resulting in death. Morphine in moderate doses, administered after washing or emptying the stomach by emetics, is recommended as an antidote. Artificial respiration and inhalation of carbon dioxide and oxygen are useful in the early stage of depression.

Although it is a powerful drug, its medicinal properties appear to have escaped the ancient physicians of India as it has not been mentioned in the Hindu materia medica. It is remarkable that, while absolutely worthless drugs were carefully collected and sent to the plains of India from the very localities in which belladonna is abundant, not a single leaf or root of Indian origin of this valuable drug could be purchased from the Indian drug shops in large centres some years ago. Its identity was so much eclipsed that no mention of this drug could be found in Dymock's *Pharmacographia Indica* or in Mohideen Sheriff's book both of which are known to be very exhaustive and reliable treatises on the Indian indigenous drugs. Belladonna is used in medicine in two forms *Belladonna folium* and *Belladonna radix*. *Belladonna folium* consists of dried leaves and tops collected when the plant is in flower. The alkaloid content (as hyoscyamine) varies from 0.15–0.7 per cent. the average being 0.4 per cent. The B. P. minimum is 0.3 per cent. *Belladonna radix*, the dried roots (alkaloids 0.60–0.66 per cent.; B. P. minimum 0.4 per cent.) are generally harvested in autumn. These are richest in alkaloid content when a year old, but it is not profitable to harvest at this time as the size is too small. Usually second or third year roots are collected. After collection the roots are washed, the large ones sliced and rapidly dried. It grows in great abundance in the Himalayan ranges extending from Simla to Kashmir at an altitude of 6,000 to 12,000 ft. above the sea-level and is also found wild in Kunawar at an altitude of 8,500 ft. A limited supply of the root can be obtained from the northern Himalayas from localities not too far away from places with suitable transport facilities.

In Jammu and Kashmir State it is found common in the forests of Sindh, Jhelum, Lidder and Chenab valleys. It is also found in Himachal Pradesh, Kulu

and Parbati valleys and in Narkanda forests of Simla hills. In order to study the quality of Indian belladonna growing in a state of nature, its roots and leaves were collected from wild sources from different places in Kashmir, Himachal Pradesh, Kangra and Kulu valleys. The specimens were found, on an average, to contain the following percentage of alkaloids:—

<i>Source of Plants</i>			<i>Parts Used</i>	<i>Alkaloid Content</i>
Kashmir	....	....	Leaves	0.25–0.40 per cent
			Roots	0.30–0.50 " "
Himachal Pradesh	....	....	Leaves	0.35 " "
			Roots	0.68 " "
Kangra and Kulu valleys			Leaves	0.48 " "

Both the roots and the leaves were exported in large quantities during the World Wars, but they did not find much favour due to low alkaloid content. The reasons, perhaps, were that: (1) the leaf at all stages of growth and roots, of both mature and immature plants, were collected and exported, and (2) adulteration with roots and leaves of *Phytolacca acinosa* occurred in consignments shipped abroad and that accounted for the lower alkaloid content. Systematic studies were carried out to determine the cause of the lower alkaloid content of both the root and the leaf. It was thought that it might be possible to improve the quality by regulating the time of collection when the leaves exhibit the maximum percentage of active principles. Fortnightly collections of leaves, beginning from June, from wild plants were, therefore, made from different forest areas in Kashmir. It was observed that the percentage of alkaloid was maximum in the leaves when the plant starts flowering in July–August. As the season advances, the alkaloid content of the leaf decreases and is minimum at the fruit bearing stage which takes place in November. Apart from the natural sources of belladonna in the hilly regions of India, considerable quantities of the roots could be grown in various suitable situations in India. The important factors in the cultivation of belladonna are regular drainage, a soil having porosity and containing sufficient mineral constituents, *e.g.* potash, soda, lime, etc., a warm hilly situation with protection from sunlight by deciduous trees and sufficient room for the roots extending to a distance from the parent plants. These requirements are not difficult to attain and as not much manuring is required in belladonna plantations, a heavy item of expenditure on this score is dispensed with. There is every possibility that belladonna cultivation would succeed, in view of the fact that in India fungus disease of the belladonna roots, which has caused havoc in the plantations in some of the foreign countries, is not yet reported.

CULTIVATION.—The excessive extraction of belladonna from the forests of Jammu and Kashmir State for the last two or three decades has enormously decreased the output of the drug and the quantity now available falls much short of the demand of the growing Indian pharmaceutical industry. The quality has also deteriorated. Generally the collection of the drug from wild sources is also

tedious and very expensive. Experimental cultivation was taken up at a number of places such as in the temperate climate of Kashmir valley and Parbati valley in the Punjab. Attempts to grow *A. acuminata* as a winter crop in Jammu province at an altitude of 1,000 ft. above sea-level have also been successful. Experimental cultivation is attempted in Darjeeling and Nilgiri hills also. The propagation of the plant has been carried out by three methods, i.e., by seeds, by root divisions, and by shoot cuttings. Two nurseries, one in Srinagar (5,000 ft.) and the other at Yarikah (7,000 ft.) were started to study the different methods of propagation.

SEED GERMINATION.—For studying the germination period a small quantity of the seed of *A. acuminata* was pretreated with different concentrations of sulphuric acid for varying periods. It was observed that the seeds sown in early March at Srinagar originally took 4-5 weeks to germinate. This period was considerably shortened when the seeds were pretreated for two minutes with 80 per cent. sulphuric acid. It was also observed that the seeds germinated in 10-15 days when sown in the warmer months of June or July without any pretreatment. The day temperature during this period reached 80°F. or more, although night temperature was low. The germination of the seeds seems to be influenced by the time of sowing and the day temperature plays an important role. Mukerji and Dutta have reported that belladonna seeds germinate in 14-21 days when kept at a day temperature of 70°F., although the night temperature may be low.

The seedlings could be transplanted when they had developed roots, i.e., in early autumn, in well-prepared beds. The vegetative growth of the autumn transplantings was, however, stunted and frost had adverse effect on the young roots of many of the plants. It has been considered better to transplant the seedlings in the following spring. In spring the vegetative growth of the plant is more rapid than in autumn and there is an added advantage that the cutworm (*Agrotis flammetra*), which is active in the months of June-July, is not there to damage the young transplants. While transplanting the seedlings, a wedge about 2-3 in. deep, is made in the soil and the young root of the seedling is laid upright and the soil around it is pressed a little. Water is sprayed around the transplant soon after. If the transplanting is carried out late in June or July, it is advisable to shade the plant with some pine needles to minimize the transpiration of the young seedlings before the roots are well established in soil. Spraying of the plant is continued till the plant bears new young leaves. The young seedlings are very sensitive and need careful handling.

Root Division.—Roots of 3-4 years or more of age are cut transversally in small pieces of 1 in. in size with a growing bud in each piece, and each is planted in well prepared soil. It was observed that belladonna plant grows vigorously and assumes height and foliage to the same extent as the parent plant in a short time.

SHOOT CUTTINGS.—This method consists in cutting a growing shoot and transplanting it in well-prepared beds and frequently irrigating it. Propagation would be more successful if done in early spring, a time when many shoots of the parent plant are not available. The shoots, which may be about 1.0-1.5 ft. long are cut at their bases and planted about 6-9 in. deep in the soil. The larger leaves at their bases are removed. When irrigated frequently the shoots give new buds and leaves in about a month's time if planted in early spring.

IRRIGATION.—It has been observed that the plant requires a fair amount of water for proper development of leaf and root and the soil should be well drained as accumulation of water is harmful to the roots. Flood irrigation or hand spraying of water is found to be beneficial to the seedlings when they have taken firm roots. In the dry months of June and July fortnightly irrigation is advantageous. The seed matures in October–November and the water requirement of the plant at that time is the least. These aspects need further systematic study.

WEEDING.—At a place like Yarikah, where the farm is situated at an altitude of 7,000 ft., numerous weeds grow in the belladonna plantations. In the months of April and May, a number of species of *Brassica* come up. These small herbs need weeding out before seed formation. The other troublesome weed is *Stachys sibirica*. This plant has a very small-sized seed and it matures and disperses, the weed growth in the coming seasons would be too profuse to allow the belladonna plant to flourish. There are numerous other weeds and grasses that have been observed growing in belladonna plantations, viz. *Ageratum* sp., *Verbascum thapsus*, *Senecio* sp., etc. So far the only control measure that has been found effective and cheap is rooting out the weeds before flowering. It has been observed that due to heavy working of soil the weed comes up vigorously in the first few years.

COLLECTION AND DRYING.—It has been previously reported that the maximum percentage of alkaloids in the leaf is found at the stage when the plant starts flowering by about the first week of August. The plant is cut with a pair of garden scissors, about 2 in. above the ground, and the harvested field is irrigated soon after. The plant puts out shoots again and even more in number. The second flush may be harvested in September. The harvested plant is chopped into pieces, particularly the young herbaceous shoots, and dried by spreading the whole harvest in thin layers in the sun. The material is periodically raked to see that the leaves at the bottom do not get heated.

YIELD.—No data to assess the yield per acre of Indian belladonna (*A. acuminata*) under cultivation have so far been compiled. The fresh crop of the aerial parts of the plant consisting of leaves and stems works out, on an average, to about 4,000 lb. per acre (weighed green) when the area is fully stocked and the plantation is in the second year. The ratio of the leaf to stem, on the average is 50: 50 by weight. On an average the yield of the crop per acre for

the whole year comes to 500 lb. (dry weight) consisting of 44 per cent. stems and 56 per cent. leaves. The percentage of moisture has been found to be more in the stems than in leaves. On an average the stems contain 88 per cent. The moisture content of the leaves varies from May to November; the amount present in both leaves and stems is maximum during April-May. It generally decreases in the following months and reaches the minimum in October-November.

PESTS.—*Agrotis flammetra*, the cutworm or grub, proves very fatal to the whole of the plantation when the seedlings are transplanted. It cuts the succulent stem above the ground and thus kills the whole plant. It is most virulent in the dry months of June or July, but its incidence decreases during rains and in the months of September-October. It is, therefore, thought advisable to complete transplantation of belladonna seedlings in April-May so that the root system can develop before the insect can attack. This insect is common in Kashmir and does considerable damage to other cereal crops. The larva of *Gonocephalum* sp. of the family Tenebrionidae (order Coleoptera) has also been observed to attack the roots of the plant. A number of caterpillars and beetles have also been found attacking the leaves, flowers and even the fruits. Recently, downy mildew has been observed on the leaf of belladonna. A few control measures for these insects are under investigation, but at present the best way out seems to be early transplantation whereby the period during which the incidence of the pest is high is avoided. The problem of controlling insect and fungus damage to belladonna requires thorough and systematic study.

Preliminary work on the cultivation of *A. acuminata* by different methods of propagation at nurseries located at different altitudes has given encouraging results with respect to the alkaloid content of the leaves:—

SOURCE OF LEAVES*	ALKALOID CONTENT,† per cent.	
	1950	1951
From plants raised from seedlings raised at Srinagar nursery (5,000 ft.) and transplanted at Yarikah	0.31	0.59
From plants raised from seedlings from wild plants in forests (9,000 ft.) and transplanted at Yarikah (7,000 ft.)	0.43	0.76
From plants collected from wild plants in the forest and propagated by root division at Yarikah	0.32	0.76

*The leaves were collected when the plants were flowering.

†Average of 10 analysis.

Thus it appears that the leaf of belladonna raised from seedlings or root cuttings has low alkaloid content during the first year of their planting but shows remarkable increase during the second year.

In order to compare the yield of active principles with that of the local belladonna seeds of *A. belladonna* Linn. procured from Royal Botanical Gardens, Kew, England, were raised in the nurseries at Yarikah and Srinagar. The difference between the local and the English belladonna is marked in the colour of the flowers, the forms of the leaves and the habit of the plant. In English belladonna the average height of plant is 12-27 in., the leaf varies in length from 3.2 to 9.2 in. and in breadth from 1.5 to 4.5 in. The branching is divaricate and the leaf is ovate.

The plant was also propagated by root division at Srinagar and Yarikah nurseries. The alkaloid contents of the leaves from the plants are as follows:—

SOURCE OF LEAVES*	ALKALOID CONTENT† per cent.	
	1950	1951
From plants raised from seedlings raised at Srinagar nursery (5,000 ft.) and transplanted at Yarikah	0.42	0.51
From plants raised from seedlings raised at Srinagar nursery (5,000 ft.) and transplanted at Yarikah nursery (7,000 ft.)	0.40	0.61
From plants collected from wild plants in the forest and propagated by root division at Yarikah	0.41	0.64

*The leaves were collected when the plants were flowering.

†Average of 10 analysis.

HYBRID SPECIES.—A natural hybrid of *A. Belladonna* and *A. acuminata* has also been observed in the plantation. It is different in certain morphological characters from both the parent plants. The colour of corolla in the hybrid species is yellow at the base but purple at the tips and the alkaloidal percentage in the roots and leaves is intermediate between the parent plants. Leaves of *Atropa* species contain traces of physiologically inactive volatile alkaloids as compared with roots which contain larger percentage of volatile alkaloids. Their percentage is maximum in *A. acuminata* and minimum in *A. belladonna*, while the hybrid species shows an intermediate content between the two.

EXPORT TRADE.—Medicinal preparations of belladonna and its alkaloid atropine were largely imported into India. A perusal of the records shows that a considerable export trade in these raw materials has existed between India and Europe for a long time. During the Wars this trade flourished extraordinarily and unprecedented values were realised by the growers, partly due to general scarcity of the article in the world market and partly to the reputation of the Indian root as possessing an alkaloidal content much higher than the European.

varieties. The Indian belladonna actually contained a higher proportion of alkaloids as seen from the analyses which were carried out. A number of specimens of the roots contained 0.81 per cent. of total alkaloids, as compared with 0.45 per cent. laid down in the British Pharmacopoeia, and the leaves contained 0.50 per cent. as compared with 0.3 per cent. Of late years, the price of roots and leaves in foreign markets has gone down and the Indian export trade has received a set back. Like many other raw products of Indian origin, Indian belladonna is already looked down upon in foreign markets; for this the Indian dealer is not a little to blame. Adulteration has been practised to a great extent. Not only plants in all stages of growth have been collected by the ignorant labour employed but a plant known as *Phytolacca acinosa* whose roots resemble belladonna roots has frequently been used as an adulterant. A large portion of the wild Indian belladonna exported to England of late years, consisted of this mixture. Further, in view of the fact that no cultivation on scientific lines existed anywhere in India, a steady supply and uniform quality of the drug could not be ensured. Though the export trade in belladonna has decreased considerably, a happy feature noticeable lately is that the manufacturing firms in India have now taken to the preparation of galenicals from the Indian root for the use of the public. The manufacture of alkaloids on a small scale was also taken up by some manufacturing firms in India during the World War II.

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CAMELLIA SINENSIS (Linn.) O. Kuntze (Theaceæ)

Syn. *Camellia thea* Link; *C. theifera* Griff.

THE TEA PLANT

VERN.—Hind, Beng. and Mar.—*Chai, Cha*; Tam.—*Thayilai*; Tel.—*Theyaku*.

COFFEA ARABICA Linn. (Rubiaceæ)

THE COFFEE PLANT

VERN.—Arab. and Ind. Bazars.—*Kahwah*.

Caffeine is one of the most important alkaloids used in medicine. Its properties, as a stimulant to the central nervous system and circulation, and as a diuretic, make it a very valuable therapeutic agent. Both the alkaloid and its salts, e.g. caffeine citrate, caffeine and sodium benzoate, etc., are largely employed in medicine.

Caffeine is the principal alkaloid occurring in tea and coffee plants and in similar stimulants such as Kola nut, Mate or Paraguay tea and Guarana paste. It is also contained in the leaves of the *Theobroma coca* but only in very small amounts. The various peoples of the world prefer different caffeine beverages, but coffee and tea alone are really competitors. There are constant national preferences with respect to them. The number of plants used as substitutes for genuine tea in different parts of the world is very large and nearly 200 are known. These plants, as a rule, do not contain caffeine; some of them contain an essential oil but not possess the properties of the purine compounds, caffeine, theobromine, etc.

It is well-known that tea—both its name and the beverage itself—came originally from China. The habit of taking tea had existed there from very early times and it is probable that it was in use as a drink in the fifth century, if not earlier. It was also known in India (Assam) from very early times but the exact period when the use of tea started is not known with any degree of precision. At the beginning of the ninth century, it reached Japan, but it was not till the end of the sixteenth century that the rest of the world became acquainted with the properties of tea. It was introduced into England early in the seventeenth century but in the year after the Restoration it was still a curiosity. In the days of Queen Anne, tea began to be a frequent though still occasional indulgence of the fashionable society but as the centuries wore on, tea drinking spread rapidly and became no longer a curiosity or a fad but a regular habit and a part of people's dietary. In 1636, tea was drunk in Paris and shortly afterwards it found its way into the different countries of Europe. Chopra *et al.* (1942) reported that the earliest reference of the use of tea dates from the year A.D. 519 when it is stated that Darma, who went to preach the Buddhist religion in China, discovered the wonderful properties of the plant. It is difficult to say whether the knowledge of tea originated in China or whether it came from Assam in India. Its use as a stimulating beverage spread to Tibet and Mongolia, and hence in a westerly direction to Europe. In 1616, the East India Company sent 2 lb. of tea to King Charles II of England, and some time later one kg. was sold there for £3 sterling. In 1636 the first advertisement of tea appeared in the 'Mercurius Politicus' as follows: "The excellent Chinese beverage, recommended by all doctors, which the Chinese call 'teha' and other nations 'tray' or 'the', is on sale in the Cafe of the Sultana near the Royal Exchange". Shortly afterwards tea was praised in Latin verse and found its highest eulogy in a book by a Berlin author: "A cup of tea is a medium for ensuring health and long life." The Dutch doctor, Bontekoe, who later became the physician of the Prince Elector of Brandenburg, prescribed one hundred to two hundred cups a day. He himself drank tea day and night. During recent years tea drinking has become universal all over the world. In India 50 years ago, very little tea was drunk and it was practically unknown in the plains of northern parts of India, especially in the rural areas and among the poor. Nowadays tea as a beverage is used even in the most out of the way places and even by the poorest. Consumption of tea has increased enormously in this country during the last 30 years. According to a moderate estimate between 10 to 20 million people in this country take tea habitually.

Coffee (*Coffea arabica*) had been known for a long time to the Arabs or Persians as a substance endowed with marvellous properties and from them, it is believed, the habit of coffee drinking spread to Europe and other countries. It is said to have been presented by the Archangel Gabriel to Prophet Mohammed when he was sick. It is said that the beans of the coffee plant remained awake and jumped and gambolled about at night. This gave him the idea of preparing a beverage for himself and his *derwishes* in order to keep awake during the long night prayers in the mosque. The beverage was called Kahweh, i.e., that which stimulates or suppresses the appetite for food. Coffee was used by almost the entire population of Asia Minor, Syria and Persia in the sixteenth century. The Kola nut (*Sterculia acuminata*) is used by the population of the vast territory of the Sudan (Central

Africa). between the Atlantic Ocean and the source of the Nile. The Yerba Maté or Paraguay tea (*Ilex paraguensis*) and Guarana paste (formed from the ripe dark-brown seeds of *Paullinia sorbilis* or *Paullinia cupana*) are also extensively used in Brazil, Paraguay, Virginia, Carolina, etc., in South America even to this day. With the exception of some of the Mohammedan countries, the use of coffee is not nearly so extensive as that of tea, perhaps because of its higher price. In India very little coffee is taken, and with the exception of southern India the use of coffee is practically unknown among the indigenous population.

HABITUAL USE OF CAFFEINE.—It is indeed interesting to note in what mysterious way or with the aid of what instinct, man has been able to select from the immense vegetable world, the plant most suitable and desirable for his purposes. Quite different plants have been discovered in three different continents of the world, America, Africa, and Asia which are all used as beverages and which are all characterised by the sole and all important feature, a content of caffeine. Lewin (1931) in his book *Phantastica* remarks, "We know in fact that man has attached himself tenaciously to the caffeine plants and their derivatives, and daily satisfies the desire they have inspired in him. And this for good reasons. An abyss separates the properties and action of these plants from those of the other substances described in this work. Consciousness is not obscured by a veil of dimness or darkness, the individual is not degraded by the destruction of his free will to animal instincts, and the soul and mental powers are not excited to the inward perception of phantasms. The caffeine plants exercise an exciting action on the brain without giving rise to any mentally or physically painful impressions. All these facts assign a particular place to these substances." It is well-known that moderate quantities of tea and coffee are not only not harmful but are even beneficial. When taken in excess they produce harmful effects.

The Tea and Coffee Resources of India

Average samples of tea leaves contain from 2.5 to 3 per cent. of caffeine, though some varieties may contain as much as 4 per cent. Coffee beans, in which caffeine occurs partly free and partly in combination, rarely contain more than 1.5 per cent. Maté contains from 1 to 2 per cent. Guarana paste from 3 to 4 per cent. and Kola about 3 per cent. of caffeine. We will confine ourselves mainly to the consideration of tea, as caffeine is obtained industrially almost entirely from this product. Though caffeine is also obtained in the manufacture of 'caffeine-free' coffee and has been prepared synthetically from urea and similar bodies, it is not obtained in an economically profitable yield.

In India, both tea and coffee plants grow luxuriantly. Coffee is grown principally in Madras, Coorg, Mysore, Travancore and Cochin. The total area under coffee cultivation was 1,60,800 acres in 1929 with an estimated yield of 27,76,700 lb. of cured coffee and 1,97,826 acres with a yield of 3,02,917 cwt. in 1947-48. This is a very satisfactory figure but cannot be compared with the huge production of tea in India. Almost all the tea consumed in foreign countries is derived from India, Pakistan, Ceylon, the East Indies, and the Far East. With the rapid increase in consumption of tea in England (Annual consumption of tea in 1840 amounted to 1.2 lb. per head and at the close of the century it was 6.07 lb. per head)

and the Continent, an expanding market was available and the tea-growing countries such as India and Ceylon extended their resources to meet the ever-increasing demand. China remained the most important tea-producing country for a long time but gradually India came into the field and through the efforts of the British tea planters, the Indian tea industry progressed by leaps and bounds. The extent, to which the trade has progressed, can be judged from the fact that in 1703 the import into England was somewhere about 1,00,000 lb. and in the year of the battle of Trafalgar, it reached 7.5 million lb. At present it is grown in many provinces in India, e.g. Assam, Bengal, Bihar and Orissa, the Uttar Pradesh, the Punjab, Madras, Coorg, and the States of Tipperah (Bengal), Travancore, Cochin and Mysore. A high rainfall is essential for its growth. The seeds are sown between November and March and the seedlings are transplanted when they are at least 6 months old. The crop is plucked from May to December in northern India and from January to December in southern India.

ECONOMIC ASPECTS.—India is the largest producer and exporter of tea in the world, excluding perhaps China about which statistics relating to acreage and production are not available. Out of a world output of 938 million lb. in 1948, India produced 567.75 million lb., Ceylon 299 million lb., Pakistan 44 million lb., and Java and Sumatra, 28 million lb. The following statements give the acreage, production and export of tea in the principal producing countries of the world:—

COUNTRY	AREA		ANNUAL PRODUCTION		ANNUAL EXPORT	
	THOUSAND ACRES		(MILLION lb.)		(MILLION lb.)	
	1937-41	1942-46	1937-41	1942-46	1937-41	1942-46
India	833.8	840.4	460.0	549.0	351.4	361.0
Ceylon	554.4	550.6	244.6	280.8	232.4	266.0
Nyasaland	18.4	19.8	11.4	12.8	11.0	12.6
Kenya	14.0	15.8	11.8	13.6	9.6	10.0
Netherlands East Indies	518.3	367.0	177.0	—	159.4	3.0
Formosa	110.6	93.5	26.8	12.8	21.6	18.7
Japan	98.0	75.6	126.2	92.2	39.8	8.0
Soviet Union	123.8	—	21.8	—	—	—
China	—	—	—	—	—	—

In India the major areas of production are concentrated in the north-east region comprising Brahmaputra and Surma valleys of Assam and Darjeeling and Jalpaiguri districts of Bengal. This region accounts for nearly 73 per cent. of the total. In south India tea growing is confined to the high elevation areas of Nilgiris, Malabar, Mysore, and Travancore which together account for 20 per cent. of the total. The acreage under tea showed considerable increase following World War I and reached 7,50,000 acres in 1933 when further expansion in area was controlled by International Tea Regulations. While the acreage under tea has risen by about 60 per cent. since the beginning of this century, the production of tea has doubled. This is due to the increase in yield per acre, from about 384 lb. in 1900 to 685 lb. in 1949 brought about by sustained improvement in plantation management. The latest report of Central Tea Board reveals that there are 6,240 tea gardens covering 7,85,584 acres of land in India.

Possibilities of Caffeine Manufacture in India

The tea and coffee resources of India being so well developed, it is indeed disappointing that the alkaloid caffeine is not manufactured here and that the country is completely dependent on foreign manufacturers. Caffeine cannot be economically manufactured from coffee but it can be manufactured from tea. Further, it is not necessary to use good tea suitable for human consumption in the manufacture of caffeine. In the preparation of finished tea for the market, a large amount of fluff and sweepings are left over. These are known as 'tea wastes' and are unfit for human consumption. Tea waste is available at a cheap price and caffeine is usually manufactured from it. It has been estimated that the yield of tea waste and sweepings in the manufacture of finished tea amount to 1.5 per cent. on an average, though this may vary slightly in different districts in India. According to the report of the Indian Tea Cess Committee, India exported about 38,25,94,835 lb. of tea by sea and land in the year 1929-30. In the preparation of this amount of finished tea, 38,25,948 lb. of tea waste would, therefore, be available. If caffeine is produced from this tea waste nearly 57,388 lb. could be produced, even if the alkaloid available from 50 to 60 million lb. of tea used in India is not taken into consideration. In large scale extraction about 1.5 per cent. of caffeine could be recovered from tea waste.

In actual practice, however, many difficulties have to be faced. Though there is no law which interferes in any way with dealings in tea waste in India, it is not sold by the Indian Tea Association to the public at large but only to reliable parties in view of the fact that tea waste and sweepings constantly find their way into the bazar as adulterants of good tea to the detriment of the tea industry generally. With a view to avoid adulteration of good tea with worthless stuff, the Indian Tea Association usually exports the tea waste to foreign countries for the manufacture of caffeine. In the year 1927-28, 41,14,638 lb. of tea waste to the value of Rs. 4,41,671 were exported. In 1948-49 the export was 67,02,300 lb. valued at Rs. 14,30,000. If tea waste is sold to the Indian manufacturers at the price at which it is exported, it should be possible to manufacture caffeine economically, which in fact is now being done.

Caffeine (Theine), $C_8H_{10}O_2N_4$, is the principal alkaloidal constituent of tea, coffee and some other beverages, in which it occurs either free or combined as caffeine chlorogenate. The percentages present in the different materials are: tea 1.0-4.8; cola nuts, 2.7-3.6; coffee, 1.0-1.5; maté (*Ilex paraguensis*), 1.25-2.0; and guarana (*Paullinia cupana*), 3.1-5.0. Cocoa waste contains theobromine from which caffeine can be obtained by methylation. The leaves of a species of holly, *Ilex cassine* (indigenous to North America) from which the beverage Cassina is prepared, contains 1.0-1.6 per cent. caffeine.

Commercial caffeine is obtained from tea waste or tea dust by solvent extraction. When boiling water is used as solvent, the decoction is treated with litharge to precipitate gums and resinous matter and the filtrate concentrated until crystals

of caffeine separate out. The product is purified by recrystallisation from boiling water. Caffeine is manufactured in India from tea waste (caffeine content, 3.0-4.5 per cent.) available in abundance from the tea gardens of Assam, Jalpaiguri and Darjeeling by benzol extraction. The raw material, mixed with soda and water is charged into brass extractors fitted with condensers and working on the Soxhlet extractor principle. On the completion of extraction, the solvent is distilled off and the residue taken up with water. The aqueous extract is treated with basic lead acetate to eliminate chlorophyll, resin, waxes and gums, and filtered through bags. Excess of lead is removed from the filtrate by treatment with sulphuric acid and the lead free filtrate decolorised with activated charcoal and concentrated. The caffeine which crystallises out is separated in a centrifuge and dried at room temperature.

The total annual output is about 20,000 lb. and the target of production is 30,000 lb. (Report, Panel on Fine Chemicals: Drugs and Pharmaceuticals, 1947, 20). There is an abundance of raw material for caffeine production in the country. Large quantities of tea waste are still exported to U.S.A., Canada and Australia for caffeine extraction. The quantities exported in 1948-49 and 1949-50 were 6.7 and 8.0 million lb., valued at Rs. 14 lakhs and Rs. 16.7 lakhs respectively. The Government of India are now taking necessary steps by enactment for retaining sufficient quantity of tea waste in the country for caffeine manufacture.

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CANNABIS SATIVA Linn. (Cannabinaceae)

Cannabis indica

TRUE HEMP, SOFT HEMP

VERN.—Sans.—*Ganjika*, *Bhanga*, *Hursini*; Hind. and Beng.—*Ganja*, *Bhang*, *Charas*; Pers.—*Darakte-bang*; Arab.—*Kinnab*; Tel.—*Ganzai*, *Kalpam-chettu*; Tam.—*Ganja*, *Bhang*; Kan.—*Bhang*.

The hemp plant originally was a native of western and central Asia, but it is now widely-distributed and largely cultivated in temperate and tropical countries. It is remarkable that hemp grown in India is of a very different character from that grown in Europe and other places, and that is why it was given the distinctive name of *C. indica* which has now been abandoned. It grows wild all over

the Himalayas. There are no botanical characters to separate the Indian plant from *C. sativa*. Hemp, therefore, as a fibre-yielding plant is in no way different from hemp as a narcotic-producing one. Some authorities have, however, mentioned certain differences in the seeds of *C. indica* and common hemp, thereby implying that the two plants may be distinct varieties. There is no doubt, however, that the female plant cultivated for fibre in Kumaon and other places yields considerable quantities of *charas* and it is sometimes smoked as *ganja*. The dried flowering or fruiting tops of the pistillate plant *C. sativa* are used in medicine.

Preparations of *C. indica* have been in use as intoxicants in Asiatic countries and Africa from times immemorial. Bhang, ganja, charas, etc., are habitually indulged in by many millions of mankind. Its narcotic and anodyne properties were appreciated by western medical men in the early parts of the last century and it was made official in the British and United States Pharmacopoeias. The plant is met with in various parts of the world, but in few other places does it attain the same degree of pharmacological activity as it does in India. The female plant is taller than the male and its foliage is darker and more luxuriant; it takes from 5 to 6 weeks longer to ripen. The height of the plant, however, varies greatly with season, soil and manuring; in some districts it varies from 3 to 8 ft. but in other places, it is not unusual to see plants from 8 to 16 feet in height.

According to Prain, the hemp plant is not indigenous to India, but, having reached India as a fibre-yielding species, the plant developed the narcotic property for which it is now cultivated. Watt is not so decided on this point. The plant has been found wild to the south of the Caspian Sea, in Siberia and in the desert of Kirghiz. It also grows in a state of nature in central and southern Russia and to the south of the Caucasus. The plant has been known in China since the sixth century B.C. and is possibly indigenous on the lower mountain hills. It grows wild in Persia. In India it is found growing wild on the western Himalayas and Kashmir and is supposed to be acclimatised to the plains of India. The internal relation of various Asiatic names to Sanskrit *bhanga* seem to fix its ancestral home somewhere in Central Asia. It may be mentioned here that there are other fibre plants, *Crotalaria juncea* and *Hibiscus cannabinus*—products growing under the name of hemp, but these cannot be regarded as true hemp.

SPONTANEOUS AND WILD GROWTH OF HEMP PLANT.—*C. sativa* grows wild throughout the Himalayas from Kashmir to east of Assam. It disappears at altitudes higher than 10,000 ft. It extends down the southern slopes of the mountains, and into the Punjab and Gangetic plains to a limited distance. It is found in the hill tracts of Assam and spreads along the mountain tracts of East Bengal. The southern boundary of the area runs approximately from Peshawar through the middle of the Punjab and the Uttar Pradesh and then follows the course of the Ganges. It is practically naturalised in the sub-Himalayan tract in India and is abundantly met with in waste lands from the Punjab eastwards to Bengal and Bihar and extending south wards to Deccan. In this region, the plant propagates itself, but it is possible that the growth on the lower slopes of the Himalayas and in the Terai springs to a large extent from seeds carried down

from the mountains. In the populous parts of the sub-Himalayan tracts, the wild growth is kept up in great measure by fresh importation of seed from the ganja and bhang which are consumed by the people. The plant appears to be very hardy when it is once well established, but it is clear from the distribution of the wild growth in India that the conditions of soil and climate under which it can attain full growth are limited. The soil need not be rich, but it should be well-drained and permeable.

CULTIVATION OF HEMP PLANT.—The hemp plant has never been cultivated in India to any great extent. The Hemp Drugs Commission (1893-94) obtained statistics of the areas under cultivation and found that after deducting the fibre cultivation, which yields but little of the narcotic drugs, the total area under cultivation could hardly exceed 6,000 acres. Since then there has been considerable decrease, owing to the limitation put by the League of Nations in the production of narcotic drugs. Figures for 1935-36 show hardly 1,600 acres under cultivation.

CHEMICAL COMPOSITION.—The first important work on the chemistry of charas was that of Wood, Spivey and Easterfield (1896). Working with a sample from the U. P., they found the following important constituents: (1) a terpene, $C_{10}H_{16}$, b.p. 165–175°, yield about 1.5 per cent.; (2) a sesqui-terpene, $C_{15}H_{24}$, b.p. 258–259°, yield about 1.75 per cent.; (3) a small amount of a paraffin hydrocarbon, $C_{28}H_{60}$, m.p. 64°; and (4) a toxic red oil or resin, $C_{18}H_{24}O_2$, termed *cannabinol*, b.p. 265°, yield about 33 per cent. The red oil sets to a semi-solid mass, insoluble in water but dissolving easily in alcohol, ether, benzene, glacial acetic acid and organic solvents generally. It gave a monoacetyl and a monobenzoyl derivative, proving the presence of a hydroxyl group, and was therefore termed *Cannabinol*. It was considered by the authors to be the active principle of the drug and Marshall (1897) showed by physiological experiments on himself and on others that this was so. Later (1899) they showed that the *cannabinol* isolated by them was a mixture of at least two compounds having similar physical characters. They have retained the name *cannabinol* for the pure compound $C_{21}H_{26}O_2$ (obtained by hydrolysing the crystalline acetyl derivative of m.p. 75°) whilst the original crude *cannabinol* is probably a mixture of this and one or more compounds of lower molecular weight. The authors also described a series of derivatives and decomposition products of pure *cannabinol* which throw some light on the probable constitution of the compound. Bauer (1927) concluded that *cannabinol* is not an ester, acid, aldehyde, ketone or phenol but is probably of the nature of a polyterpin. Cahn (1930) suggested the correct formula for *cannabinolactone*, a decomposition product of *cannabinol* isolated by Wood, Spivey and Easterfield.

Other investigators have obtained apparently constant boiling resins and, although these yielded only oily derivatives, they have claimed homogeneity for each product, appropriated the name *cannabinol*, and variously assigned to it the formulae $C_{20}H_{30}O_2$ (Casparis 1926; Bergel, 1930) and $C_{21}H_{30}O_2$ (Fränkel, 1903;

Czerkis, 1907). The most recent work of Cahn (1931) was carried out with several different samples of 'hashish' of uncertain origin, all of which gave similar results and these were confirmed with a *C. sativa* resin of known Indian origin. His work and that of Wood, Spivey and Easterfield have shown that the apparent constancy of boiling point cannot be held to prove the homogeneity of these resins, and that the resins of Fränkel, Czerkis, Casperis and Bergel were all mixtures. The name cannabinol, $C_{21}H_{26}O_2$, should be applied only to the substance obtained from the acetyl derivative of m. p. 75° and the apparently constant boiling resin should be termed 'crude cannabinol'. According to Todd (1939) hemp resins contain several active constituents. The following compounds have been isolated in crystalline form: cannabinol, cannabidiol, cannin, and cannabol. The structure of cannabinol has been confirmed by synthesis. In addition to the above, the drug contains a small quantity of a laevorotatory volatile oil, containing terpenes, and a sesquiterpene (cannibene); also choline, trigonelline, and calcium carbonate. It yields about 15 per cent. of ash and from 10 to 18 per cent. of alcoholic extract. Indian hemp is reported to be almost inert at the end of two years under ordinary conditions of storage. Deterioration appears to be due to the action of an oxydase enzyme.

Use of Hemp Drugs for Euphoric Purposes

C. sativa and its products are used for narcotic purposes in India in two different ways: (1) By smoking and (2) By mouth.

PREPARATIONS USED FOR SMOKING.—Ganja is known in Hindustani, Bengali, Marhatti and Punjabi as *Ganja*, in Tamil *Ganja-yala*, in Telegu *Bangi-aku*. Ganja consists of the dried flowering and fruiting tops of the female plant from which no resin has been removed. The flat or Bombay ganja which is exported to the U. K., occurs in agglutinated, flattened masses of dull green or of greenish brown colour. The resin is no longer sticky, but is hard and brittle, and the odour, which is very marked in the fresh drug, is faint. The drug has a slightly bitter taste. Here and there ovoid hemp seeds may be picked out. Ganja is collected only from cultivated plants. Since the policy of the Government is to prohibit ultimately all narcotic drugs, the area under ganja cultivation has progressively declined. Hemp grown under Governmental supervision in three small villages adjoining Ahmednagar in Bombay is supposed to yield the best quality drug. For the production of ganja, the plants are cultivated in rich, weed-free soils, well prepared and well manured. They grow well on light loamy or sandy soils in tropical humid climate, and are grown as a monsoon crop, sown in June or July and harvested in December or January. Their cultivation is of an intensive character as for other garden crops. Seeds with high germination capacity are obtained from Almora and other sub-Himalayan regions, and sown in rows 4 ft. apart, the seed rate being 5-8 lb. per acre. When the plants are 20 cm. high, they are thinned out. The field is kept clean of weeds and is often irrigated. As growth proceeds, the lower branches are lopped off to stimulate the growth of flowering branches. Flowering starts in November and male plants are cut down or pulled out since they produce little resin.

The harvesting of plants for ganja starts when the lower leaves fall off and the top of the flower stalks begin to turn yellow. The floral spikes are cut and removed to the manufacturing yard and spread out in ridges and furrows. The ridges are levelled down and trod upon to press the floral shoots into compact sheaves. At intervals the material is turned over, allowed to dry for some-time and trodden again. They are then collected

and arranged in a flat circular heap called *chakki*, more layers being added until the required height (2-3 ft.) is reached. The compacted mass is kept under pressure for some time to promote chemical changes. The heaps are turned over, broken up, spread out again in a thick layer and treading resumed. On the fourth day, the ganja is ready for storage in special sheds. There it is sifted free of dust, stones, seeds and leaves and then sent to the ganja depot at Ahmednagar. Insufficient treading results in a semi-dry loose sheaf, while insufficient attention during the process gives a less valuable product. Two types of ganja are known—the flat or Bombay ganja and the round or Bengal ganja. In the preparation of the latter, instead of trampling down the harvested material into a flat cake, the withered tops are rolled into small rounded or sausage shaped masses between hands or under feet. The broken fragments and powder of flat and round ganja constitute the Chur-Ganja or Rora. The average yield of ganja is about 250 lb. per acre but a good crop may yield up to 350 lb. and in exceptional cases about 425 lb. per acre. Ganja of good quality yields 15-25 per cent. resin on extraction with carbon tetrachloride and the ash content should not exceed 15 per cent. Cannabis B.P.C. contains not more than 10 per cent. fruits, large foliage leaves and stems over 3 mm. diam., and not more than 2 per cent. of other foreign organic matter; acid-insoluble ash, limit 5 per cent.; matter soluble in alcohol after drying at 100°, not less than 10 per cent.

SMOKING OF GANJA.—Most of the ganja produced is used up for smoking, though a small quantity is also used for taking internally in certain parts of India, e.g. Puri, Madras. The process of preparing the drug for smoking is simple. A small quantity of the drug, usually about 1 to 2 gm., is taken and moistened with a little water and rubbed in the palm of the left hand with the right thumb for a short time till the stuff becomes sticky. It is then mixed with a little ordinary tobacco and smoked in a *chillam*. The intoxicating quality of the drug is said to increase with the length of the time spent on rubbing it but this is doubtful. Ganja is largely used by Hindu sadhus such as 'Jogis,' 'Bairagis' and Mohammedan Fakirs and mendicants as a class. Poor classes and menials of all descriptions, such as syces, grasscutters, sweepers, weavers, day labourers, etc., smoke it. It is also used by criminals to drug people with a view to making them insensible and robbing them. For this purpose ganja is mixed with the seeds of black datura and sugar and a sweet is made out of these.

CHARAS.—Charas is the name given to the resinous matters which form the active principle when collected separately. It is really the concentrated resin exudate collected from the leaves and flowering tops or agglutinated spikes of *C. sativa*. There is practically no evidence that charas is prepared in the plains. Various methods of preparing charas in this country have been described. Sometimes men dressed in leather suits or jackets pass through the field of *C. sativa* rubbing and crushing roughly against the plants early in the morning just after sunrise and when a fall of dew has taken place. The resinous matter, which sticks on, is then scraped off and forms the ganja resin of commerce. In Kulu and the Hill States, the flower heads are said to be rubbed between the hands and the accumulated resin is scraped off. The resin is also said to be collected by treading the plant with the feet. Sometimes the flowering twigs are simply beaten over a piece of cloth and the greyish white powder which falls is collected.

In Yarkand, *C. sativa* flourishes and is said to be cultivated on a large scale in Bokhara and other places in Turkestan. The Russians, however, prohibited its cultivation many years ago within their territory so that the supplies are almost entirely obtained from Yarkand territory. Practically all the charas imported to India came through Leh in Kashmir State and certain amount also came through Kulu. A depot for storing the drug was established in Leh. According to estimates of the excise authorities, the total import amounted to 5,000 mds. in 1892-93, but this was an exceptional year. Usually 3,000 to 4,000 mds. were imported.

BHANG.—*Bhang*, *Siddhi*, *Subji* or *Patti* is the dried leaves of *C. sativa*, whether male or female, and whether cultivated or uncultivated. The term has also been sometimes made to include the female flower heads as well as the leaves of the plant, and the green leaves as well as dry leaves. It is also probable that male flower heads must also enter into it as the methods of preparing bhang are very crude, the plant being simply dried and the leaves being separated by beating it against a block of wood or hard ground. It must, however, be remembered that the male flowers are not more narcotic in their action than the leaves, unlike the female flower heads.

Bhang is commonly the name given to the drink made out of *sabji*; ganja pounded up and made into a drink, as is done in case of Garhjat ganja in Puri, also is called bhang. For this reason in many parts of India especially in the south and west the distinction between ganja and bhang is lost. Bhang here is the name given to the most simple style of consumption, viz., pounding and drinking, which in the evolution of its narcotic use must have preceded smoking. Although bhang is a more comprehensive term and often includes ganja in the north, in south India ganja is a more general term, and in some places is made to include even bhang, the latter term being quite unknown there. Bhang is consumed either as such or as liquid infusion. The simplest method of consuming is to pound bhang with spices and to swallow the paste in the form of a bolus. It is also consumed in the form of sweetmeats. A sweet preparation known as 'maajun' is made by mixing the pounded leaves with sugar and forming the mixture into small rectangular cakes.

Bhang is prepared from both the uncultivated plant and a small quantity from cultivated plant. The plant is cut and is alternately exposed to sun and dew. When the leaves are dried they are pressed and stored in earthenware vessels. Bhang is also the name given to the refuse of the treading floor when ganja is prepared. The usual time for gathering leaves for preparation of bhang varies with the locality in which it is grown, but it is usually in the months of May and June in lower altitudes and June and July in higher places. The bhang obtained from some localities is regarded as superior to that obtained from others. There is no evidence to show that the cultivated plant yields a superior quality of the drug.

The use of hemp drugs to produce euphoria is very widespread in Asia and Africa. It has been established beyond doubt that the use of Cannabis to induce intoxication is of Asian origin. Europe and the Far East have so far been affected to a lesser extent. This practice has, however, gradually spread all over the entire eastern end of the Mediterranean and in the area along the northern parts of Africa as far as the Atlantic. The east coast of Africa has not escaped and the drug has penetrated to the centre of the continent, where it constitutes a danger which is difficult to check. It has also reached America (Jamaica, Brazil, Mexico, U.S.A., and Canada) where it is smoked in form of cigarettes under the name of 'marihuana'. Infact marihuana smoking is becoming quite a problem among the juveniles in the U.S.A. In Egypt the inhabitants smoke hashish (charas), a preparation made from *C. sativa*. The drug is also used to a great extent in North Africa from Tripoli to Morocco and in these parts it is preferred to opium. The whole of Algeria is full of hashish smokers. The habit as a rule is prevalent among the poorer classes such as camel and donkey drivers. On the west coast of Africa the passion for the drug exists in isolated parts, but is more apparent among the Congo Negroes wherever they live, e.g. Liberia. They cultivate it and smoke the fresh or dried leaves in pipes in which a piece of glowing charcoal is placed. Along Loango coast, hemp is smoked in form of leaves and seeds in water-pipes. Further south, hemp smoking has become a popular custom among

the Hottentots, Bushmen and Kaffirs. It is smoked either alone or with tobacco. Hemp smoking is also greatly in vogue in East Africa, with the exception of the territory between the lakes. They smoke the hemp which they themselves cultivate. The cultivation of hemp formerly flourished greatly in Turkey, but was prohibited towards the end of the last century, though this did not prevent its clandestine use. A preparation of hemp called Esrar (secret) is smoked together with tobacco. Hemp in other forms is chewed. In Syria, hemp is cultivated and the resin is carefully collected. In Damascus there are many dens where opium and hashish are smoked and so also in Persia. Uzbeks and Tartars are addicted to hemp.

In India the use of hemp is wide-spread. In Bengal and Bihar ganja is largely smoked and bhang is used to a small extent; in the U. P. ganja, charas and bhang are all largely used; in the Punjab charas and bhang are to a great extent consumed; in Sindh bhang is largely consumed and ganja and charas are used to a lesser extent; in Bombay, and Madras States and Central India ganja is largely consumed, bhang to a lesser extent and charas very little. The use of bhang in some parts is connected with religious and social observances. The conclusions of the Hemp Drugs Commission, India (1893-94), were that the moderate use of hemp drug appeared to cause no appreciable physical injury. They also came to the conclusion that moderate use produced no injurious effect on the mind. The popular belief that hemp drugs lead to insanity was not justified by the data before the Commission. The Commission also thought that moderate use produces no moral injury, and there was no adequate ground for believing that it injuriously affected the character of the consumer. Excessive consumption on the other hand was physically and mentally injurious; it produces and intensifies moral weakness and depravity. Manifest excess leads directly to loss of self-respect and thus to moral degradation.

PSYCHOLOGICAL EFFECTS.—Chopra and Chopra (1939) conducted a detailed comprehensive survey of drug addiction in India and arrived at the following conclusions: "The use of hemp resin for narcotic and sedative purposes is ancient and widespread. Hemp drugs are consumed all over the world mainly for euphoric purposes. Their use alleviates the feeling of fatigue, encourages sleep and soothes restlessness. In small doses they sharpen appetite, which sometimes becomes so ravenous that it cannot be appeased by food. They promote digestion but cause also constipation. If indulged in for long they cause loss of appetite and gastric derangement. Hemp drugs act chiefly on the cerebrum and in this they resemble the action of alcohol or opium. The action is uncertain due to variations in the strengths of various preparations and due to individual peculiarities. Unlike addiction to opium, morphine or heroin, in which the victim must have the drug to feel normal, the hemp drugs addict wants to recapture the pleasurable euphoric state into which the drug lands him. It is more of a psychological condition, there being no marked physiological disturbance on withdrawal of the drug. Ganja smoking is almost universal with certain classes of sadhus and mendicants. If continued, it causes intoxication and loss of self-

control. The drugged man becomes talkative and jovial, has less control over himself and eventually passes into a sort of waking delirium. Hemp drugs are therefore called euphorics, exhilarants, delirians and hypnotics. In larger doses they induce a sort of catalepsy, followed by coma and death from cardiac failure. Excessive smoking of ganja, especially by beginners, may cause mental derangement and even insanity. Hemp drugs have also an anodyne action, though in this respect they are inferior to opium or belladonna. Physiological changes in circulation and respiration are not marked, though prepared bhang taken as drink is known to cause copious diuresis." Dr. J. Bouquet (1951) observed that cannabis is a drug which affects the mind most powerfully. Besides producing a delirious excitement of the imagination and stimulating the memory to an extraordinary degree, it engenders a state of exhilaration, well-being and bliss which are of the greatest attraction to addicts.

ACTION AND USES.—Cannabis is used in medicine to relieve pain, to encourage sleep, and to soothe restlessness. There is little definite knowledge of the therapeutic effects produced, but in some persons it appears to produce euphoria and will often relieve migrainic headaches. One of the great hindrances to the wider use of this drug is the great variability, in the potency of different samples. Because of occasional unpleasant symptoms from unusually potent preparations, physicians have generally been over-cautious in the dosage administered. The safest way of determining the dose of an individual preparation is to give it in ascending quantities until some effect is produced.

PRODUCTION AND TRADE.—As bhang is obtained from plants growing wild, no reliable figures of the area under bhang production can be given. Charas is not produced in India. It was formerly imported overland from central Asia (Yarkand) but imports have now ceased. Ganja is the only product for which cannabis is cultivated under licence. The total area under cultivation in Bengal, Bihar, Central India and Bombay was estimated at 538 hectares. The combined area under ganja and bhang (for which separate figures are not available) in Madras was 112.5 hectares. Illicit cultivation of hemp plant is rare.

PRODUCTION AND CONSUMPTION OF HEMP DRUGS IN INDIA

Area Under Cultivation (hectares)			Hemp Drug Harvested (kg.)		Hemp Drug Consumed (kg.)		
For Fibre	For Drug		Ganja	Bhang	Ganja	Bhang	Charas
1944	110.5	650.5	410,509	646,700	203,684	439,216	565
1945	"	613	416,807	638,072	228,847	524,377	49
1946	"	438	323,537	214,618	214,660	438,630	—
1947	"	207	149,037	210,639	153,560	205,668	—

Ganja is the form in which the drug is mostly used in Bengal, Bihar, Bombay, Madras and Central India, bhang is used only to a small extent. Both charas and bhang are used in the Punjab while in U. P. the drug is used in all the three forms.

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CARUM CARVI Linn. (Umbelliferae)**THE CARAWAY SEED**

VERN.—Sans.—*Sushavi*; Pers.—*Karoya*; Arab.—*Karoya*, *Karawya*; Hind.—*Shia-jira*, *Zira*; Beng.—*Jira*; Punj.—*Zira-siah*; Tam.—*Shimai-shembu*; Tel.—*Shimaisapu*; Sind.—*Kaluduru*; Kash.—*Gunnyun*; Bomb.—*Wilayati-zirah*.

C. carvi is widely distributed in the temperate regions of both the hemispheres. It grows in north and central Europe, extending to the Caucasus, Persia, Tibet and Siberia. It is found growing wild in north Himalayan regions. On account of its general importance as a cookery condiment and as a spice in bakery products and in some kinds of cheese, it is cultivated in various parts of the world, e.g. Morocco, Germany, Norway, North America, Holland, Rumania, etc. In India it is cultivated as a cold season crop on the plains and as a summer crop on the hills, e.g. in Baltistan, Kashmir, Kumaon, Gharwal, Chamba, etc., at an altitude of 9,000 to 12,000 ft.

A valuable essential oil rich in carvone is obtained from the seeds. This oil is colourless or pale yellow with a strong odour and flavour of the fruit. The yield varies from 3.5 per cent. to 5.2 per cent. according as the entire seeds or the coarsely ground seeds are distilled. It also contains 8 to 20 per cent. of fixed oil, proteins, calcium oxalate, colouring matter and resin. The volatile oil consists of the ketone, carvone, and the terpene, limonene, with small quantities of dihydrocarvone, carveol, dehydrocarveol. If it is intended to produce a freely alcohol-soluble oil with especially high carvone content, the whole seed must be used. Oil distilled from wild caraway seeds usually shows a high specific gravity and hence is not much preferred. It is sparingly used in medicine but finds ready employment in flavouring wines, scenting soaps and in perfumery. Caraway grown in different localities in Kashmir showed the following percentage yield of oil (Chopra 1947).

	Yield of Oil	Sp. Gravity	Ref. Index at 20°C.
Baghbanpura (5,500 ft.)	4.3 per cent.	0.9095 at 15°C	1.491
Gurez (7,900 ft.)	6.8 "	0.8902 at 15°C	1.486
Skardu (7,700 ft.)	8.5 "	0.8907 at 15°C	1.485

Caraway oil is used chiefly for flavouring purposes and in medicine as a carminative. It is used to correct the nauseating and griping effects of some

medicines. For the treatment of scabies a solution of caraway oil, alcohol and castor oil is recommended. Decarvonised oil with traces of carvone is sold in the market as light oil of caraway which is used in scenting cheap soaps. The official oil is required to contain 53 to 63 per cent. of carvone.

CULTIVATION.—The plant requires a dry climate and thrives well in well tilled soils rich in humus. The fruit may be sown either broadcast or in rows 12 in. apart. Being a biennial crop it may be grown with annuals like dwarf peas, mustard or field leaves. The fruit is collected before ripening. Well ripened fruit may also be harvested. The plants are dried and fruits thrashed out. The yield is very variable ranging from 6 to 16 cwt. per acre depending on the nature of soil.

Cultivation of caraway has made great headway in Holland. The area planted with caraway is gradually on the increase, and in 1926 the harvest yielded about 4,500 tons of seed. In 1927, the total export of caraway amounted to 60,00,000 kg., the chief consuming countries being Germany, the United States, Czechoslovakia, Great Britain, etc. The seeds and the oil derived from them are employed in those countries in the various industries mentioned above. In India, wild caraway would be available in large quantities provided arrangements could be made to collect the harvest together in outlying places. This involves heavy transport charges and is not commercially practicable. Cultivation on a large scale holds out good prospects in India and the oil should find a ready market in the rapidly growing soap, cosmetic and perfumery industries of the country.

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CARUM COPTICUM Benth. & Hook. f. (Umbelliferae)

Trachyspermum ammi (Linn.) Sprague

THE BISHOP'S WEED; LOVAGE; AJAVA SEEDS

VERN.—Sans.—*Yamani*; Hind.—*Ajowan*; Beng.—*Jowan*; Bomb.—*Ajwān*, *Owa*; Tam.—*Oman*; Tel.—*Omamu*; Arab.—*Kamue mulūki*; Pers.—*Ziniān*, *Nākhkhwāh*.

CUMINUM CYMINUM Linn. (Umbelliferae)

CUMIN

VERN.—Sans.—*Jiraka*, *Jira*; Arab.—*Kamuna*; Pers.—*Zira*; Hind.—*Jira*, *Zeera*; Beng.—*Jira*; Mar.—*Jiregire*; Tam.—*Siragam*; Tel.—*Jilakara*, *Jiraka*; Kan.—*Jserige*; Mal.—*Jorekam*; Punj.—*Zira-sufed*; Sind.—*Zero*.

The seeds of ajowan and dry fruits of cumin are the rich sources of thymol in India, although species of *Origanum*, *Ocimum*, *Mentha viridis* and *Thymus serpyllum* are also reported to contain thymol in their essential oils. Thymol or

thyme camphor is contained in a number of essential oils occurring in many plants, among them being the common thyme or *Thymus vulgaris* Linn., from the leaves and flowering tops of which thymol is commonly distilled. It is also obtained from *T. zygis* Linn. *T. vulgaris* is a small evergreen shrub belonging to the Labiatae family. It is indigenous to Spain, Portugal, France and Italy but is extensively cultivated in other parts of Europe and America, especially in New York State and Germany. The latter country supplies most of the commercial article. Thymol also occurs in the oil from *Monarda punctata* Linn. (Labiatae) to the extent of 60 per cent. and also in *Monarda didyma* Linn. both of which are indigenous to North America. Besides these it is also manufactured from Piperitone which is available in a large amount from the essential oil of Australian broad-leaved peppermint (*Eucalyptus olives*) of the Myrtaceae family and from citronellal which is obtainable in a large amount from the essential oil of the south Asian Citronella grass (*Cymbopogon nardus* Linn.) of the Graminae family.

The seeds from *Carum copticum* syn. *Trachyspermum ammi* (Linn.) Sprague, are worth special mention in this connection. Ajowan as it is called has long been used in Indian practice in diarrhoea, atonic dyspepsia, cholera, colic, flatulence, indigestion, etc. It possesses carminative, stimulant, tonic and antispasmodic properties. The fruit has an aromatic smell and a pungent taste. Mixed with 'pan supari' or even alone it is often used as a masticatory. The fruit yields 2 to 4 per cent. of a colourless to brownish essential oil in which thymol is present to the extent of 35 to 60 per cent. Thymol crystallises easily from the oil, and is sold in India as ajowan-ka-phul (flowers of ajowan). The remainder of the oil consists of p-cymene, α -pinene, dipentene, α -terpinene, and carvacrol, the mixture being known commercially as thymene on account of its similarity to the corresponding portion of thyme oil. Ajowan oil, both pure and dethymolised, is employed in India as an antiseptic and aromatic carminative. Its action and uses are similar to thymol which is a powerful antiseptic and finds varied application in medicine, e.g. in the treatment of nasal catarrh and skin diseases, as a mouth-wash, and as an anthelmintic. It is also occasionally used in soaps and perfumery.

Cumin water, which is commonly used in India as a carminative and is believed to be useful in flatulence and griping, especially in children, is the water left over after the essential oil and thymol have been removed from the steam distillate.

The fruits from which the essential oil has been removed contain 20 per cent. of a fatty oil and 15 to 17 per cent. of proteins. The exhausted fruits may, therefore, be used as a food for cattle, as has been done in Germany. The fresh herb from Germany has been found to yield 0.12 per cent. of a yellowish brown essential oil, which contains some phellandrene and about 1 per cent. of thymol. The Indian herb has been reported to contain a small quantity of α - and β -phellandrene and an uninvestigated paraffin. Moslene (identical with α -terpinene) is also present.

The plant (*Carum copticum*) grows and is widely cultivated all over India; it is particularly abundant in and around Indore and in Hyderabad (Deccan).

Nearly 7,000 to 8,000 acres of land were reported to be under cultivation in the Hyderabad State and ajowan seeds valued at 1 to 1.5 lakhs of rupees were stated to be exported every year. The large seeded variety is chiefly used for home consumption and grows in the Kurnool, Guntakul district. It is also cultivated in Bengal, Madhya Pradesh and Madhya Bharat. In India it is sown in October to November on ridges, the fruit being dibbled every 6 in. Strong manures are said to be harmful, but a liberal supply of water is desirable. The herb flowers in February to May, and fruits in May to June. The ajowan oil was an important source of thymol, and large quantities of the fruit were exported to Europe, particularly to Germany and the U.S.A., before the World War I for its distillation and the manufacture of thymol. During World War II and after, large scale distillation of the fruit and manufacture of thymol were also organised in India. The extraction of thymol from ajowan oil was, however, considered unremunerative later and could not stand competition with thymol of synthetic origin or from other vegetable sources. If the yield of oil could be substantially improved and the yield of fruit per acre increased, there is every chance of reviving the industry. This appears quite possible since it has been reported that fruits cultivated in Seychelles contain 9 per cent. of oil having 38 per cent. of thymol as against the yield of 2-4 per cent. of the essential oil from the Indian fruit. In other words Seychelles fruit yields about twice as much thymol as the Indian ajowan, even though the oil is somewhat poorer in thymol content. The question of careful cultivation needs proper investigation in India, particularly in view of the fact that during the last few years the manufacture of thymol from this source is again being revived in the country.

Besides this, *Cuminum cyminum*, another plant which is abundantly cultivated all over India as a field or garden crop contains a large quantity of cumin oil whose chief constituent is cumic aldehyde, which again can be readily converted artificially into thymol. Cumin is largely used by the people in India as a spice in curries. It is also used in the indigenous medicine as a stimulant and carminative.

CULTIVATION.—*Cuminum cyminum* is a slender annual herb native of Egypt and Syria but is cultivated in all the states of India except Assam and Bengal. The chief producing centres are the Punjab and U. P. In Jaipur an area of about 13,930 acres are under cumin cultivation in Khalsa territory. About 2,000 acres are under cumin in Bombay, mostly in north Gujerat. In Madras it is cultivated over limited areas in Coimbatore, Cuddapah and Kurnool districts. In India the crop is grown in two seasons, either before the start of south-west monsoon or after the end of north-east monsoon. It is susceptible to excessive heat or moisture or heavy rains during the growing period. For the early crop, fruits are sown at the end of April or beginning of May, while for the late crop they are sown about the end of October. They are sown broadcast, 30 to 35 lb. per acre. Moderate and regulated irrigation is necessary till the fruits ripen. Weeding is also necessary. The fruit ripens in 2 to 3 months after sowing, and, when mature, the plants are pulled out with roots, dried, and thrashed. An

acre of land yields 250 to 300 lb. of the fruit, but sometimes a yield of as much as 400 lb. per acre is also reported. According to Sievers (1948) the plant thrives best on a well-drained, rich sandy loam in regions where temperatures are mild and equable during the growing season of three or four months. Complete control of weeds is necessary because the plant is small and tender. For this reason, planting the fruit in rows spaced to permit maximum use of cultivators would be preferable to broadcasting in areas where manual labour is costly. The crop is ready for harvest when the plants wither and the fruit loses its dark-green colour. The yield of fruit is reported in the Mediterranean region to range from 100 to 1,000 lb. per acre, with 500 lb. a fair average under reasonably good conditions. The aromatic fruit, like that of caraway, dill, anise, etc., possesses well-marked stimulating and carminative properties. It is extensively used for flavouring curries, soups, etc., and is an ingredient of curry powder, pickles, and chutneys. It is also used to an extent in Indian medicine, being replaced by caraway which has a more agreeable flavour.

ECONOMIC ASPECTS.—The aromatic cumin fruit, known in commerce as seed, is sold both whole and in ground condition. When ground for commercial purposes, it should be fine enough to pass through a mesh 54 screen. According to Parry (1945), the fruits should not contain more than 9.5 per cent. of total ash, not more than 1.5 per cent. of ash insoluble in hydrochloric acid, nor more than 5 per cent. of foreign matter. The fruit on distillation yield 2.5 to 4.5 per cent. of a limpid, pale-yellow essential oil with the characteristic odour of the fruit, the older fruit yielding less of oil. The fruits obtained from a local bazar in Bangalore yielded 2.35 per cent. of an essential oil. Cumin oil is employed advantageously instead of the fruit in many types of flavouring preparations, particularly in curries and culinary preparations of oriental type. Infact cumin was one of the commonest spices in the Middle Ages. It is also used to an extent in soap perfumery, and in flavouring beverages. In medicine it is sometimes used as a carminative. Cuminaldehyde has a powerful odour and is used only in traces in compounding synthetic floral perfumes, such as cassie. The oil is chiefly employed in veterinary practice. Cumin oil is often adulterated with synthetic cuminaldehyde, the presence of which cannot be detected analytically, except that the addition of an excess of the latter affects the optical rotation of the oil. The exhausted fruits contain 17.2 per cent. of proteins and 30 per cent. of fat. They should be of value as cattle feed. India exports large quantities of cumin fruits to foreign countries, particularly to the Straits Settlements, Malaya, and E. Africa. Her average annual exports during the five years, 1945-46 to 1949-50, amounted to about 1,600 tons valued at Rs. 23,08,000. During the three years, 1944-45 to 1946-47, she also imported from Afghanistan on an average about 160 tons of cumin fruits valued at Rs. 2,40,397 annually. The chief trade centres in India for these fruits are Jubbulpur, Ratlam, Jaipur, and Gangapur.

The commercial value of thymol has greatly increased of late years on account of its use as an anthelmintic against hookworm infections and also as an antiseptic,

forming part of many proprietary preparations. India can not only supply her own requirements of thymol from the rich store of raw material she possesses, but can also produce enough of surplus store for export. Germany had captured the markets of the world with thymol obtained by distillation from *T. vulgaris* cultivated there, and by synthesizing it from crude phenol. Synthetic thymol is now finding its way into the market in larger and larger quantities. Previous to 1914, thymol was produced chiefly from natural sources. It is now produced not only from the comparatively cheap meta-cresol, but another source has become available in the form of the ketone 'piperitone'. This can be produced in large quantities from the Australian eucalyptus which can be easily and cheaply grown anywhere in that country. Though thymol occurs in fairly large proportions in the oil of ajowan, no attempt was made before the World War I to distil the oil from the fruits in India.

Though thymol has been produced in several parts of India in substantial quantities there are difficulties to be encountered in manufacturing the drug in India. Most of the seeds obtained in the market have apparently been partially distilled as their oil content is very low. The ajowan oil available averages only 4 to 6 per cent. of thymol and must be evidently de-thymolised. In 1924, experiments were actually conducted under the auspices of the Department of Industries and Commerce, Hyderabad, on the manufacture of thymol from ajowan seeds growing there. It was found that the yield of oil was only 2 per cent. of the weight of the seeds and the yield of thymol crystals was 36.97 per cent. on the weight of the oil. This showed that the quality of the seeds was rather poor in comparison with the foreign seeds. On calculating the actual cost of production, it was found that the price could not compete with the market price of the imported article unless the by-products of the manufacture, namely, extracted seeds (as fodder or manure), omum water and thymene oil, were also utilised. The manufacture of thymol, from the seeds and oil procured from the market, is fraught with great risks and is not likely to be remunerative. Attempts were made during the World War I to cultivate this plant in other parts of the world. A sample of seeds from the Seychelles gave on analysis 9 per cent. of the oil and from Montserrat 3.1 per cent. of oil containing 39 and 54 per cent. of thymol respectively. These figures show a much higher yield than that obtained from the Indian fruit (about 2.85 to 2.91 per cent.). More attention should, therefore, be paid to the proper cultivation of ajowan seeds on scientific lines in suitable parts of India. If this is not done the trade in this drug is likely to be seriously affected. Unless the quality of the seeds is improved, India will not be able to compete with other countries growing a superior quality of seeds. In view of the increasing production of synthetic thymol it is desirable to give protection to this industry.

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CASSIA ANGUSTIFOLIA Vahl (Leguminosæ)

INDIAN OR TINNEVELLY SENNA

VERN.—Sans.—*Bhumitari, Bhupadma*; Hind.—*Hindi sana*; Guj.—*Nat-ki-sana*; Beng.—*Sona-mukhi, Son-pat*; Mar.—*Shona-makhi*; Tam.—*Nila virai*; Tel.—*Nela-tangedu*; Kan.—*Nelavarike*; Mal.—*Nila vaka*.

Senna leaves are well-known in the Western medicine for their laxative and purgative effects. The preparations 'confectio sennæ' and 'pulv. glycyrrhizæ co' are two of the popular remedies of the Pharmacopœia. The activity of the drug is due to cathartic acid; the other constituents are emodin (trioxy-methyl-anthraquinone), chrysophanic acid, etc. These are contained in the leaves though the pods also possess them; the legumes are said to be more active when green. The drug has been known to the Arabs for many centuries and it is believed that it was introduced into Indian and European medicine through them. Even today the Arab physicians extol the merits of senna as a purgative and as a cordial when mixed with suitable drugs such as violets (*Banafsha*). Two varieties of Cassia have been recognised by the British Pharmacopœia: (1) Alexandrian senna and (2) Tinnevelly senna. Alexandrian senna is obtained from the wild plants of *C. acutifolia* Delile, growing in Africa and Sudan. The leaflets of this species are shorter and narrower than those of *C. angustifolia*, which is cultivated extensively in Tinnevelly, Madura and Trichinopoly. Recently, it has been introduced in Mysore and Jammu and is found to do well. *C. acutifolia* is reported to be cultivated in India (cultivated Alexandrian). Tinnevelly senna (*C. angustifolia*) leaves are paripinnate and the leaflets which form the drug are 1–2 in. long, 0.2–0.6 in. wide, glabrous and of a yellowish green colour. A third variety, *C. obovata*, which grows in the Deccan is sold as country senna. This was used as an adulterant to ordinary senna but was not recognised in the Pharmacopœia.

The pods of *C. angustifolia* are 1.4–2.8 in. long, about 0.8 in. wide, greenish brown to dark brown in colour, and contain 5–7 obovate, dark brown and nearly smooth seeds. The pods are larger and narrower than those of the Alexandrian variety and the brown area of the pericarp surrounding the seeds is larger. The remains of the style are distinct in the Tinnevelly but not in the Alexandrian type. The pods have medicinal and economic value, and are official in the British and U. S. pharmacopœia.

CULTIVATION.—*C. angustifolia* is cultivated usually on dry land in south India. It is sometimes grown on rice lands immediately after the rice crop is

harvested. It may be given a light irrigation and grown as a semi-irrigated crop. Heavy irrigation is injurious. Sowing is either by broadcasting or by dribbling, the seed rate being about 15 lb. per acre. The seeds have a tough coat, and a certain amount of abrading of the surface is necessary to induce even and quick germination; this is secured by pounding the seeds lightly with coarse sand in a mortar. The plants require bright sunshine and occasional drizzling. Continuous rain during growth spoils the quality of the leaves. The plants are usually allowed to grow for 3-5 months only and the first flush of flower stalks is cut off to induce lateral branching. When the leaves are fully grown, and are thick and bluish in colour, they are stripped off by hand. A second stripping is made after about a month and the plant allowed to bear flowers to set seed. The leaves are spread out on a hard floor, without overlapping to dry in shade. The layer is frequently stirred to ensure even drying. After 7-10 days, when the leaves have dried sufficiently and assumed a yellowish green colour, they are graded and packed under hydraulic compression into bales. The pods are dried, beaten out to separate the seed and packed in cartons.

A dry land crop of senna yields 300 lb. of cured leaf and 75-150 lb. of pods. The yield from a wet land crop is 750-1,250 lb. of cured leaf and 150 lb. of pods. The drug collected from wet lands has a higher market value. The acreage and yield of senna in Madras are stated below :—

YEAR	AREA (ACREAGE)	YIELD	
		LEAVES (TONS)	PODS (TONS)
1938-39	4,990	1,197	207
1939-40	5,212	1,439	247
1940-41	6,727	1,995	343
1941-42	5,817	1,637	293
1942-43	3,417	1,239	201
1943-44	992	350	55
1944-45	607	214	34
1945-46	1,178	429	66
1946-47	1,635	540	88
1947-48	2,002	486	80

Senna is valued in medicine for its cathartic properties. It is especially useful in habitual constipation. It increases the peristaltic movements of the colon. The tendency to gripe caused by senna may be obviated by combining it with aromatics or with a saline laxative. The pods have the same therapeutic effect as the leaves, but they cause less griping. Senna is contraindicated in spastic constipation and in cases of colitis.

CONSTITUENTS.—According to Maurin (1922) senna leaves contain about 1.3 to 1.5 per cent. of anthraquinone derivatives which are present in both the free and combined state. Stoll *et al.* (1941) obtained two crystalline glycosides which they call sennoside A and B. Fairbairn (1951) attributes about 30 per cent. of the activity of the drug to a third glycoside which has not yet been

isolated. Senna also contains the yellow flavonol colouring matters, kaempferol, its glycoside and isorhamnetin; also a sterol, and its glycoside, mucilage, calcium oxalate and resin. The constituents of pods are similar to those of the leaves. Maurin found 1.3 per cent. of anthraquinone derivatives in Tinnevely pods and 1.4 per cent. in Alexandrian. The pods are said to be less gripping than leaves as they contain less resin.

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CHENOPODIUM AMBROSIODES Linn. (Chenopodiaceæ)

MEXICAN TEA, JERUSALEM OAK

Chenopodium is a large genus of more than 250 species of herbs with cosmopolitan distribution. About 8 species occur in India. *C. ambrosioides* var. *anthelminticum* Gray (*C. anthelminticum* Linn.) or American wormseed is one of the most widely used anthelmintics at the present time. It was used by the American Indians in the days of Columbus and in South America infusions made from leaves and seeds have been used as a household remedy against intestinal parasites for a long time. Baumlér and Fribourg introduced the drug into Europe in 1881 for the treatment of hookworm disease but their results were not encouraging. The oil was originally used as a remedy against ascarides but was not popular on account of the toxic and sometimes fatal effects produced in some cases. Schüffner and Vervoort (1913) tried it against hookworms in Sumatra in 3 c.c. doses with castor oil and chloroform, and obtained results superior to those obtained with thymol, beta-naphthol, etc. From this time on, the drug came rapidly into use and received further impetus during the World War I when the supply of anthelmintic remedies such as santonin and thymol decreased. It was extensively tried by various workers and proved a very valuable anthelmintic against many forms of intestinal parasites.

Official oil of *chenopodium* is obtained principally from *C. ambrosioides* var. *anthelminticum* Gray, or American wormseed, commonly known as Mexican tea. It is an annual or perennial herb belonging to the *Chenopodiaceæ* or Goose-foot family. It is a native of Central America and the West Indies but grows wild in many parts of the United States from New England to Florida and California. According to Sievers (1948) this plant grows well under cultivation in almost any soil, but a good sandy loam is preferred. It is now cultivated for oil production only in a small area in central Maryland, mainly in Carroll County. The cultivated form of the plant does not grow so tall as the wild plant,

but produces more seed. Since the seed covering contains more oil than other parts of the plant this form gives the highest yield of oil. The seed is sown in March in well-prepared beds. Between May and June, when the seedlings are 4 to 5 in. tall, they are transplanted about 10 in. apart in rows of about 3 ft. apart. The soil is kept entirely free from weeds by shallow cultivation throughout the growing season. Harvesting is usually begun early in September or as soon as the seeds are black, but before the plants have turned brown. If harvesting is delayed until the plants are fully mature there will be considerable loss through shattering of the seed and consequently a lower yield of oil. The plants are cut and are left in the field until partly dry but not dry enough to shatter. In this condition they are distilled. The distillation must be conducted carefully because the rate of distillation and the temperature of the condenser water have an important effect on the medicinal quality of the oil obtained. If the crops were grown entirely for the seed about 1,000 lb. of the seed per acre could be obtained. In favourable years the yield of oil may be 40 lb. to the acre, but generally it is much less in some areas. In 1939, 240 farmers grew on the average 4 acres each and produced 38,000 lb. of the oil in U.S.A. At one time the fruit was official in the U. S. Pharmacopoeia but it has been discarded. The fruit from which the oil is expressed is somewhat globular, frequently more or less compressed, with a thin greyish brown pericarp. The seeds are reddish, brown or black, kidney shaped and shiny, and have a strong eucalyptus like aromatic odour and a bitter and pungent taste. A large trade in chenopodium seeds had existed in America for a long time. Nowadays chenopodium seeds are very seldom exported as the oil is distilled on a large scale in Baltimore (Baltimore oil) and in Illinois (Western oil).

CHEMICAL COMPOSITION AND PROPERTIES.—The active principle of chenopodium is a volatile oil (0.4 to 1 per cent.) which, like most of the substances of this class, is a mixture of various constituents. The oil has no definite boiling point and, when it is heated to 100°C in the air, it explodes with great violence. Different specimens of the oil differ much in their physical characters; the colour may vary from pale yellow to bright golden yellow. The toxicity of different stocks also varies considerably. The chemical composition of the oil has been extensively studied and though there is diversity of opinion regarding minor details the following composition may be taken as the standard:—

- (1) *Ascaridole* varying from 60-77 per cent. of the total oil in different samples. B. P. not less than 65 per cent. w/w. It has a definite chemical composition $C_{10}H_{18}O_2$.
- (2) Small portions of an isomer of ascaridole, the glycol anhydride or its corresponding hydrate, in proportions of 5 per cent. or more of the total oil.
- (3) A mixture of various liquid hydrocarbons, containing cymene, α -turpinene, a new λ -turpinene, etc., making about 30 per cent. of the total.
- (4)* Traces of lower fatty acids, chiefly butyric acid, and about 0.5 per cent. of methyl salicylate.

OTHER SOURCES OF CHENOPODIUM.—Though chenopodium is indigenous to Central America, it is found growing in a state of nature in the East Indies and in India. In the Philippines as many as 50 species grow but only two varieties have so far yielded oil of medicinal value. In Sumatra and several other places

of the Dutch East Indies, chenopodium has been seen. In India 6-8 are known to occur. It is interesting to note that chenopodium can also be vated in areas, where it is not indigenous, with satisfactory results. This has been done on a large scale near Weston in America where a belt of land 15 miles long and 4 miles broad was under cultivation with an average annual production of 10,000 to 40,000 lb. per 20 acres. At Deli in Sumatra and in Java the plant is grown successfully and the oil is also distilled but it differs slightly in composition from the standard American oil.

Indian Chenopodium

Chenopodium ambrosioides Linn. VERN.—Mal.—*Katu ayamoddakam*. This is an erect, much-branched herb, 2-4 ft. high, with aromatic glandular hairs, occurring in Bengal, Sylhet and south India. The flowers are minute and are clustered in leafy spikes. The entire plant is aromatic with a camphoraceous odour. The fruits are somewhat globular, slightly compressed with a thin pericarp surrounding the seeds. The seeds are small (about 1/30 in. diam.) orbicular, brown, smooth and shining, and possess a bitter, pungent taste. A volatile oil of medicinal value is found in the glandular hairs, specially of the pericarp of the fruit. The plant is closely related to, and has been used as a substitute for the American *C. ambrosioides* var. *anthelminticum* Gray. Typical forms of *C. ambrosioides* are not always distinguishable from var. *anthelminticum* because of natural intergrades. One distinguishing feature, however, is that the spikes are leafy in *C. ambrosioides*, and not so in var. *anthelminticum*. The Indian chenopodium oil is mainly derived from *C. ambrosioides*, and has an ascaridole content of 40-50 per cent. It differs from the American oil in the nature of the hydrocarbons present. It falls short of the requirements of the U.S.P. Its value as an anthelmintic has been, however, well-established and a higher dosage level, 5-20 min., is indicated in I.P.L.

C. botrys Linn. It is a strongly aromatic glandular herb, 1-3 ft. high, occurring in the Himalayas from Kashmir to Sikkim. The fresh plant on steam distillation yields 0.03-0.04 per cent. of a yellow ethereal oil with a disagreeable odour, containing 5 per cent. aldehydes and ketones, and 1 per cent. phenols. Ascaridole is not present. The plant has been employed as a substitute for *C. ambrosioides*. In France and southern Europe, it is reported to be used for catarrh and humoral asthma.

C. album Linn. VERN.—Hind.—*Bethu sag*, Beng.—*Chandan betu*, *Bethu sag*, Tam.—*Parupukkirai*, Tel.—*Pappukura*. This is a small odourless herb occurring in many forms, wild and cultivated, throughout India up to an altitude of 14,000 ft. In the western Himalayas it is grown as pot-herb and a grain crop. The plant contains an ethereal oil, a substance resembling cholesterol, and ammonia and amines both in free and combined forms. Analysis of the seeds gave (on dry wt. basis), protein, 15.4-16.8; fat, 5.8-8.1; nitrogen-free extract, 47.7-50.0; crude fibre, 18.4-21.5; and ash, 4.8-7.0 per cent. The fixed oil from the fruits

contains 2.29 per cent. unsaponifiable matter, 2 per cent. linolenic acid, and traces of ascaridole. *C. album* is reported to contain carotene, 7.1–9.3 mg./100 gm. and vitamin C, 66–96 mg./100 gm. The growth of the plant is greatly stimulated by magnesium. The plant may serve as a field indicator for this element.

C. blitum Hook. f. (Punj.—*Kupald*) found in Kashmir, and *C. murale* Linn. (Punj.—*Bahu*, *Kurund*, *Kharatua*) which occur in most parts of India are used as pot-herbs.

In view of the importance of the drug, experimental cultivation was started at Mungpoo in the Darjeeling district and also in the Bangalore gardens in Mysore State. It was recommended in the report of the Director of Botanical Survey in India some years ago that the seeds should be sown thinly in a seed-bed in March and transplanted 18 in. apart in all directions. *C. ambrosioides* which was planted grew to a gigantic size at Mungpoo and seeded well but the seeds yielded only 0.48 per cent. of oil in contradistinction to the expected yield of 3 per cent. For several reasons the cultivation of this variety has not been proved to be a commercial success in Bengal and has been discontinued. The authors obtained some seeds of *C. ambrosioides* var. *anthelminticum* from Turkey and tried their germination at various places in Jammu and Kashmir. In all the places the seeds germinated in 10–15 days and bore flowers and fruits in normal way. On steam distilling the whole plant harvested at the fruiting stage from altitudes of 7,000 and 5,000 ft. respectively yielded 1.16 and 0.82 per cent. of pale yellow oil and 8.5 and 7.2 per cent. ascaridole respectively. The plants raised at altitudes of 900 ft. and 3,000 ft. were also harvested and distilled. The yield of oil from these places was 0.75 and 1.15 per cent. respectively. In the latter places the ascaridole content of 69.5 and 66.4 per cent. respectively was obtained which compares favourably with the B. P. standard (65 per cent.). Samples of drugs collected at different stages of maturity of the plant at Jammu (900 ft.) showed a progressive increase of the ascaridole content from 27.9 at the budding stage to 69.9 per cent. at ripening stage of fruits in the first harvest. The ascaridole content of the ripe fruits in the second harvest was still higher, i.e., 75.5 per cent. The authors observed, that fully matured seeds when harvested yield the maximum ascaridole content.

THE INDIAN AND THE AMERICAN OIL.—The Indian chenopodium oil—both from *C. ambrosioides* and *C. anthelminticum*—was examined by Henry and Paget at the Wellcome Bureau of Scientific Research. The yield of the oil according to their estimation was lower. The percentage yield of oil from *C. ambrosioides* was 0.17, and from *C. anthelminticum* 0.24. The oil expressed from the Indian seeds was found to be lighter in colour, and had an odour somewhat different from that of the American wormseed oil derived from *C. ambrosioides* var. *anthelminticum*.

The constants of the Indian oil as compared with those of American wormseed oil are as follows:—

NATURE OF OIL	SP. GR AT 15°C.	SP. ROTATION
<i>C. ambrosioides</i> (Indian)	0.9399	+0.07°
<i>C. anthelminticum</i> (Indian)	0.9080	−9.6°
American Wormseed Oil	0.9669	−5.6°

From the results of the fractional distillation, the composition of the mixed Indian oil compared with that of American wormseed oil is approximately as follows:—

	MIXED INDIAN OIL (PER CENT.)	AMERICAN WORMSEED OIL (PER CENT.)
Hydrocarbons	45—50	30—40
α -terpinene	Nil	5
p-cymene	25	15
Chenopodium terpene	—	10
Ascaridole	46	65
Residue	4	5

It will be seen from the above that Indian chenopodium oil differs from good American chenopodium oil in containing less of the active principle, ascaridole, viz., only about 46 per cent. in place of 65 per cent. or more. Another difference lies in the nature of the hydrocarbons present. The American oil contains about 30 per cent. of this fraction of which about half is cymene and the other half a mixture of terpinene and a laevo-rotatory terpene. The hydrocarbon fraction of the Indian oil on the contrary is p-cymene with a small amount of dextro-rotatory terpene. The specifications of the United States Pharmacopoeia are that the oil shall have a specific gravity of 0.955 to 0.980 at 25°C. shall be soluble in 8 volumes of 70 per cent. alcohol and shall have an optical rotation between -40° and -10° in a 100 mm. tube at 25°C. The mixed Indian oil, therefore, obviously falls short of these specifications.

ECONOMIC ASPECTS.—In view of the differences between the two specimens of oil as outlined above, the Indian oil may be considered to be very much inferior. The results achieved so far clinically with the Indian oil are, however, said to have been satisfactory. It was tried by Chandler with encouraging results in hookworm disease and roundworm infestations. It will, therefore, be worth while to investigate its further possibilities. Experiments carried out in America definitely show that it is possible to improve the quality of the oil by intensive cultivation. Poor cultivation, without proper attention towards sowing and without the liberal use of fertilisers, results in a small yield. These details could be easily attended to in India. Further, in the light of work carried out by W. A. Konantz, Chief of Research Department, Quincy, Illinois, it seems probable that the quality and yield of oil are largely due to faulty methods of distillation. Nelson has laid stress on the method of distillation, stating that the chief active ingredient was unstable and was decomposed gradually on boiling with water. Consequently he suggested that the distillation should be carried on rapidly with steam at a higher pressure, the condenser kept warm and the warm distillation water separating from the oil in the receiver discarded. Russell stated that "the method of distillation is a factor which causes great changes in the oils" and that "with rapid distillation, that is with a good flow of steam, an oil was secured which passed all of the United States Pharmacopoeia requirements and contained a high percentage of ascaridole". He observed that no difference in yield and specific gravity of the oil occurred when the steam pressure at the distilling retort was 80 to 100 lb. When the pressure was reduced to 40–60 lb.

the specific gravity was lowered. The time of distillation (from appearance of distillate at discharge end of condenser) was 8 to 10 minutes. With a slower method of distillation the specific gravity was reduced. A more careful distillation, therefore, with proper attention to these points is likely to improve the quality of the oil. Though chenopodium has lost much of its ground since the discovery of the anthelmintic properties of carbon tetrachloride by M. Hall in 1921, it is still in great demand. Not only is it used as the alternative or substitute for carbon tetrachloride, but is now also frequently used in combination with it. Soper (1924) called attention to the fact that the proportions of the two drugs should depend on the nature of the worms harboured. Carbon tetrachloride alone is said to be more effective against pure necator infection and chenopodium for ascaris infections, whereas ankylostoma infections are apparently most readily cured by a combination of the two, with a relatively high proportion of chenopodium. As in India, a mixed parasitic infection is the rule rather than the exception, the demand for chenopodium will always remain. In view of the simplicity of administration and the extreme cheapness of carbon tetrachloride (Rs. 2-8-0 per lb.) as compared with the oil of chenopodium (Rs. 32 per lb.) it may not be possible to use it on an extensive scale for mass treatment. It should, however, be remembered that dose of chenopodium oil when given in combination with carbon tetrachloride is comparatively much smaller (1.0 c.c.) than when given by itself (3.0 c.c.). Maplestone (1931) has obtained much better results by the treatment of ascaris infections with a combination of santonin 5 gr. with chenopodium oil 1.0 c.c. in a capsule. In view of these facts there will be sufficient demand to justify the cultivation and production of the oil in India. Apart from its medical use, it is employed largely in veterinary practice in the eradication of intestinal parasites of domestic animals and agricultural cattle. As it is a herb which will practically grow quite well in the plains of India, it would be worth while trying its cultivation in Bengal and some of the neighbouring provinces. Kapoor *et al.* have observed that the plant has well established at altitudes of 900 to 3,000 ft. and the yield of crop and the oil produced is quite comparable to the yields obtained in America. Its cultivation in the suitable areas in the lower regions of Kashmir State is being extended for commercial distillation of chenopodium oil.

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CHRYSANTHEMUM CINERARIÆFOLIUM (Trev.) Bocc. (Compositæ)**Syn. Pyrethrum cinerariæfolium Trev.****PYRETHRUM**

It is a glaucous perennial herb, 18-24 in. high with finely cut leaves and numerous flower heads, resembling the common daisy. *C. cinerariæfolium* gives larger yields of flower heads and seeds than *C. coccineum*, but is less resistant to disease and injury. *C. cinerariæfolium* is a native of Dalmatia, Herzegovina and Montenegro, and is cultivated on a commercial scale in Algeria, Dalmatia, Australia, Brazil, Bulgaria, China, Japan, France, Italy, Persia, Spain and Switzerland. Cultivation has also been undertaken in England and in U. S. A. The term Dalmatian pyrethrum is applied to *C. cinerariæfolium* grown in the eastern coast of the Adriatic Sea. Japanese pyrethrum, also derived from *C. cinerariæfolium*, is similar to the Dalmatian in appearance. The concentration of active principles (pyrethrins) in the Dalmatian and Japanese flowers ranges from 0.38 to 0.58 and 0.58 to 1.21 per cent. respectively. Kenya pyrethrum is reported to have a higher pyrethrins content, viz., 1.43 to 1.89 per cent. Experimental cultivation of pyrethrum in India was undertaken in Kashmir and in the Nilgiri Hills in the early years of World War II. The results were very promising and the need for its cultivation was felt especially when supply from foreign sources was cut off during the War. The area under cultivation was, therefore, rapidly extended to meet at least a part of the requirements of the Defence Department, Government of India, as given below:—

Pyrethrum Production in Kashmir

(1 md.=82 lb.)

YEAR	ACREAGE	PRODUCTION OF FLOWERS (MD.)	QUANTITY SOLD (MD.)	SALE PRICE (RS./MD.)
1940	—	5.5	6	100
1941	322	33	27	100
1942	896	373	376	100
1943	1,350	1,469	1,482	90
1944	1,600	1,436	1,400	90
1945	1,744	2,154	27	60
1946	1,744	1,585	10	50
1947	1,744	788	2	40
1948	—	—	3	40

The area under pyrethrum in Nilgiris during the period 1944-47 was 1,868 acres, the production of flower heads being 1,07,912; 96,561; and 89,129 lb. in 1944-45, 1945-46, and 1946-47 respectively. There has been a progressive fall in the acreage since, and in 1949-50 the area under pyrethrum was 600 acres, the production being 2,260 lb. Attempts have been made to grow pyrethrum also in other parts of India, and encouraging results have been obtained in Kulu, Palampur, Mayurbhanj, Kumaon, Assam, Mysore, Travancore, and Kodaikanal.

The aggregate acreage under pyrethrum outside Kashmir was estimated in 1947 at 2,000. Attempts to grow the plant at Dehra Dun, Saharanpur, Dharwar, Poona, Sakrand and Ranchi have been unsuccessful. On an experimental scale pyrethrum plants grown in Jammu nursery (900 ft.) gave 0.93 per cent. pyrethrins on moisture free basis.

CULTIVATION.—Pyrethrum thrives best in a dry climate on well-drained sandy soil. Red lateritic loams are also suitable. It can grow on mountain slopes and waste lands, but too rich soils, water-logged conditions and severe frost are unfavourable for healthy growth. Sowing is usually done either in spring or in autumn. In Kashmir, seeds sown in autumn give high germination, while in Assam, the maximum number of seedlings are obtained from March sowings. The seeds required for sowing should be gathered from selected plants when the flowers are fully mature and the seeds are about to be shed. They tend to lose their viability on storage. Before sowing, the seeds are soaked in water, wrapped in cloth or sacking, and buried in damp sand. They are sown evenly in prepared nursery beds with good drainage; 1 lb. of seed gives about 15,000 seedlings. Beds are laid out on soft sandy soil, well-ploughed and brought to a good tilth. Well-rotted cow dung may be added as manure in less fertile soils. After sowing, carth is sprinkled over the seeds and the beds shaded with straw matting. In prolonged spells of dry weather, the beds should be watered regularly after sunset.

The seeds germinate in 10-15 days and the shading is removed after the shoots appear. A second dose of fertiliser, preferably night-soil, is applied to the land when the seedlings are 2-6 in. high. The beds should be systematically weeded. Seedlings (4-5 in. high) are transplanted on ridges at intervals of 7-12 in. and in rows 1-2 ft. apart. A spacing of 18 in. permits the planting of about 20,000 seedlings in one acre. Seedlings from spring sowings may be transplanted in April-July and those from autumn sowings, in October-November. Failing this, the seedlings may be left in the nursery beds and transplanted in early spring next year. Plants can be raised also from cuttings and splits as in Kenya. Splits, being larger than seedlings, are easy to handle and the need for raising seedlings on nursery beds is obviated. The plants also flower earlier. Vegetative propagation, however, is not a common practice as it is said to shorten the life of plantations. The field is irrigated only when necessary. The land must be well-drained and every precaution taken to prevent water-stagnation. Two weedings in the first year and one in subsequent years are recommended.

Application of excessive doses of nitrogenous manures induces profuse vegetative growth but supresses flowering. The principal manure used in Hokkaido plantations is stable litter with a good auxiliary manure in the form of night-soil, plant ash, fish cake, or super phosphate of lime. Stable manure is usually applied at the time of transplantation and auxiliary manures are applied after the flowers are plucked. The plants flower within one year of transplanting but the yield is poor. In the Punjab, flowering starts at the end of March

and continues till the end of May. In Kashmir, the flowering season is June-July, and in Madras, the plants are reported to flower all through the year. The first marketable crop is obtained in the third year after sowing and harvesting is continued annually for 3-4 years. The flower heads are gathered when they are about three-quarters open. It has been observed that the concentration of active principles increases with the development of the flower heads, reaching the maximum when all the disc florets are open. Theoretically, flowers should be picked just when the last florets are about to open, but this is not practicable in commercial plantations. Further the keeping quality is influenced by maturity; the active principles in over mature flowers decompose more rapidly than in immature or nearly mature flowers. The flowers are usually plucked by hand. In some parts of Europe and in the U. S. A., a scoop is employed which strips off the flower heads and deposits them in a receptacle provided for the purpose in the hind portion of the scoop.

The yield varies according to altitude. In Kenya the average yield is about 450 lb. per acre at elevations of 5,000-6,000 ft., although under favourable conditions a higher yield, up to 780 lb. has been obtained. At elevations of 8,500-9,500 ft., the yield per acre is 1,120-1,680 lb. In Kashmir, where economic cultivation is possible at elevations of 5,000-8,000 ft., optimum yields are obtained at about 6,000 ft. The average yield, viz., 90 lb. per acre, is low as compared with the reported yields from Kenya. In Assam a yield of 400 lb. per acre has been reported at altitudes of 4,000-6,000 ft., in the trial plantation at Kumaon (U. P.), a yield of 54 lb. of dry flower heads from 2 year old plants was obtained; in Mysore, the yield is reported to be 75 lb. per acre. In experimental plantations in Orissa, the average yield is 40 lb. per acre. Cold and dampness reduce the yield. Light pruning at the beginning of the dry season after picking is necessary to keep the plants sturdy. A well maintained plantation may yield even for 8-10 years. There is a gradual fall in the pyrethrin contents of harvested flowers after the third year of planting. The yield tends to become uneconomic after 3-4 harvests, and replanting is undertaken.

Harvested flower heads are usually dried in the sun in Kashmir. They are thinly strewn on straw mats and the flowers turned over from time to time to ensure uniform drying. At night they are kept under cover. Dehydration is complete in 5-7 days, drying, being considered sufficient, when on gently pressing between the thumb and the finger, the material crumbles to powder. It has been observed in Kashmir that sun-dried flower heads contain a higher percentage of pyrethrins than shade-dried flowers. Drying in the shade after initial partial drying in the sun for 3 days gives the most satisfactory product. Mechanical driers have been designed for drying pyrethrum flowers. One that is favoured in Kenya is the upward draught drier in which heated air is drawn through a series of trays containing the flowers. The correct stage of drying is reached when a flower squeezed between the thumb and the finger does not crumble to powder but does so if a rolling squeeze is given. At this stage, the material contains about 10 per cent. moisture: the natural colour of the flower is retained and the material can

be handled, packed and baled with very little damage. Over-dry flowers are brittle and break up during handling. The powdered material is yellow when fresh; after storage for some months or when obtained from old and poorly cured flowers, it is dull brown in colour. Dried and powdered flower heads have a pleasant characteristic odour. They are acrid and bitter, and cause a numbing sensation to the tongue and lips. They keep well when stored in coloured airtight glass jars or in partially evacuated tin cans.

CHEMICAL COMPOSITION.—The chief active principles of the flower heads are pyrethrin I and pyrethrin II. Their distribution in different parts of the flower and their concentration in flowers collected from different parts of India and from other sources are given below:—

PART	PYRETHRINS PER CENT.	
	FLOWER HEAD	OPEN FLOWER
Achenes	2.27	4.54
Receptacles	0.26	0.27*
Involucral scales	0.15	.....
Disc florets	Trace	0.48
Ray florets	Trace	0.18
Stems	0.15	.

*Receptacles and scales

SOURCE	PYRETHRIN I	PYRETHRIN II	TOTAL
	PER CENT.	PER CENT.	PYRETHRINS PER CENT.
Kashmir (Tangtaarg)	0.35	0.57	0.92
Kashmir (Baramulla)	0.32	0.62	0.94
Punjab (Palampur)	0.22	0.68	0.90
Punjab (Kulu)	0.35	0.40	0.75
U. P. (Dehra Dun)	0.63	0.15	0.78
U. P. (Garhwal)	0.20	0.28	0.57
Madras (Kodaikanal)	0.76	0.62	1.38
Madras (Coonoor)	0.44	0.45	0.89
Assam	.....	.....	1.41
Orissa (Mayurbhanj)	.....	.....	1.15
Mysore (Bangalore)	.....	.....	0.80
Ceylon (Hakgala)	0.47	0.57	1.04
Kenya	0.77	0.56	1.33
Dalmatia	0.35	0.63	0.98
Japan	0.38	0.63	1.01

Pyrethrin I and pyrethrin II, isolated from the oleoresin extract of the flowers by Staudinger and Ruzicka, are viscous, oily liquids soluble in hydrocarbon solvents. Pyrethrin I gives on hydrolysis an unsaturated ketonic alcohol, pyrethrolone, and chrysanthemum mono-carboxylic acid, while pyrethrin II gives pyrethrolone and chrysanthemum dicarboxylic acid. More recent work has shown that pyrethrins I and II are mixtures of substances in which chrysanthemum mono- and dicarboxylic acids are esterified with more than one, and probably several, ketones. A new ketone cinerolone has been isolated and its esters with chrysan-

themum mono- and dicarboxylic acids are designated cinerin I and cinerin II (Gnadinger, 423). Pyrethrins are highly unsaturated substances which lose their activity on hydrogenation. Isolated pyrethrins decompose to the extent of 97 per cent. in air and sunlight at a temperature of 20–25° within three days. The proportions of pyrethrins and cinerins in commercial preparations vary and with them their insecticidal potencies. Pyrethrins are about 1.3 times more toxic than cinerins, and pyrethrin I and cinerin I are nearly 4 times more effective than pyrethrin II and cinerin II respectively against house flies. Different solvents and mixtures of solvents, have been employed for the extraction of oleoresin from the flowers. By using a mixture of alcohol, acetone, and kerosene for extraction, and distilling off alcohol and acetone from the extract below 60° under reduced pressure, concentrates containing 10–12 per cent. pyrethrins have been obtained. In addition to pyrethrins, cinerins, phenolic bodies, mono- and dichrysanthemum acids, pyrethrum contains protocatechuic, isovaleric, caproic, lauric, palmitic, oleic, and linoleic acids both in the free and combined forms. Choline and stachydrine are also present. The flowers yield an essential oil (0.07 per cent.) which contains a paraffin ($C_{14}H_{30}$, m.p., 54–56°), a substance melting at 62°, a phenol, and probably, palmitic and butyric acids. Analysis of flowers from Nilgiris gave: β -carotene, 0.69 μ g., and total carotenoids, 4.7 μ g/g.

Pyrethrins are practically non-toxic to warm blooded animals when ingested, but if introduced into the blood circulation, they have a marked toxic effect, the principal site of action being the spinal cord. Cases of dermatitis and other skin affections are reported with persons allergic to pyrethrins, but toxic effects of flowers or extracts are probably due, not to the pyrethrins which are non-irritant even in concentrations as high as 93 per cent. but to phenolic constituents present in them. Pyrethrum is a contact poison highly toxic to insects. It can be used either as powder or as spray; for the latter, suitable liquid extracts, suspensions and emulsions have been prepared. The stalk and leaves also possess appreciable insecticidal activities and are sometimes constituents of pyrethrum powders employed for specific purposes. Pyrethrum preparations occupy an important place in antimalarial measures, and afford protection against a number of agricultural and horticultural pests. Pyrethrum is used as livestock spray against parasitic insects. For this purpose emulsions in heavy oils are particularly suitable. It is usual to prepare standard concentrates and mix them with heavy oil to the required dilution before use. The addition of 5 per cent. pine oil increases the repellent action against parasites and masks the odour of the oil. Pyrethrum is effective as an external application in pediculosis and scabies. In the form of an extract containing 0.75 per cent. combined pyrethrins dispersed in an ointment base of wool fat, petrolatum and paraffin, it is an efficient remedy for scabies. It is useful as an anthelmintic against *Ascaris lineata* and other intestinal parasites in veterinary practice. Pyrethrum concentrates should be stored after the addition of anti-oxidants in sealed containers. The addition of substituted dihydroxybenzenes, aminoanthraquinones, higher phenols, sulphonation products of bhilawan shell liquid or other patented compositions, ensures

the biological stability of the active principles. Biologically stable aqueous emulsion sprays have been developed in India. During World War II these and the non-greasy, mosquito-repellent pyrethrum creams were manufactured in large quantities for military use.

A number of highly chlorinated synthetic products, notably dichlorodiphenyltrichloroethane (DDT) and hexachlorobenzene, with high insecticidal activities have been commercially produced, and are in use as substitutes for pyrethrum. Their use in agriculture and dairy farming is, however, not free from danger. Liver damage has been observed in rats fed on diets containing DDT in concentrations as low as 5 p.p.m. Milch cattle fed on fodder containing DDT residues, yield milk contaminated with DDT. Pyrethrum compositions do not leave toxic residues, and their use in agricultural operations is unattended by any danger.

A part of the pyrethrum produced in India is utilised in the production of insecticidal preparations; a part is exported. The quantity consumed in Indian industry at present is approximately 50 tons per annum. India exported 938 cwt. of pyrethrum valued at Rs. 93,572 during the period February–May 1950. During the same period, 200 tons of pyrethrum valued at Rs. 3,19,000 were re-exported. There were no exports from October 1949 to January 1950. The total annual requirement of pyrethrum flowers in the country is estimated at 4,000–6,000 tons. The actual production, however, is much less, though possibilities for extending pyrethrum cultivation exist. In recent years, the demand for indigenous pyrethrum appears to have considerably decreased. A part of the area under pyrethrum on the Nilgiris is now being diverted to wattle cultivation. The limitations of the chlorinated insecticides, which are becoming increasingly evident, may increase the demand for pyrethrum. There is sufficient awareness in India of the need for organised effort to develop pyrethrum insecticides in the country and to promote its utilisation on a large scale.

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CINCHONA CORTEX (Rubiaceæ)

CINCHONA BARK; PERUVIAN BARK; JESUIT'S BARK

There is a large demand all over the world for cinchona bark and its alkaloids on account of their value in the treatment of malaria. India, taken as a whole, is probably the most malarious country in the world and naturally requires large quantities of this drug. The genus *Cinchona* comprises about 65 species of ever-green shrubs or trees which grow indigenously on the eastern slopes of the central western chain of the Andes Mountains in South America. They flourish at an altitude of 2,500 to 9,000 ft. above the sea level from Costa Rica to the southern

borders of Bolivia. Cinchona bark is said to have been introduced into Europe about A. D. 1639 by the Countess of Chinchon. The story is told that while she was in Peru with her husband, who was then Governor, she developed ague and was cured by taking the bark sent to her by the Corrigidor of Loxa. The latter had himself suffered from ague eight years previously and had been cured by it. The Countess was so convinced of the curative effects of this bark that she sent some to her husband's relatives in Spain. From Spain its fame spread to Italy and it was introduced by the Jesuits to France and England about the middle of the seventeenth century. With the advent of the English it was brought to India and has gradually replaced all the uncertain remedies used in the indigenous systems in the treatment of malaria. In 1820, the French chemist Pelletier isolated quinine, which was then practically the total alkaloids of the bark. The use of the bark became so extensive that fears were entertained that the world's supply of the bark from South America would be exhausted. Attempts were made to transplant some of the species in other countries and in 1852 the Dutch were successful in growing cinchona trees in Java. The India Government at once appreciated the possibilities of growing cinchona in India and the beneficial effects which would result from it. In 1860, through the efforts of Sir Clement R. Markham, cinchona trees were successfully planted in the Nilgiri hills in southern India and as they grew well, in 1864 plantations were also started in Mungpoo in the Ranghi valley and also in the Karen hills of Burma. The chief species of cinchona which were grown in India are *C. officinalis*, *C. calisaya*, *C. succirubra*, the hybrid *C. robusta* and *C. ledgeriana*, but *C. micrantha*, *C. lancifolia*, *C. cordifolia*, *C. trianae*, *C. paludiana*, *C. josephiana*, *C. calsopera*, etc., have also been grown.

Of these, *C. succirubra*, (red bark) has proved to be the hardiest and the most easily cultivated species. It gives a high yield of total alkaloids—as much as 10 per cent.—but the quinidine and cinchonine contents preponderate over that of quinine. It is largely cultivated in south India at an altitude from 4,500 to 6,000 ft. above the sea level. It grows well in the Tomengoo hills in Burma, on the Satpura Range in Madhya Bharat and in the Government plantations in Mungpoo, West Bengal. In Java it is grown as a root stock for *C. ledgeriana* grafting.

C. officinalis Linn. syn. *C. condaminea* Humb. & Bonpl. (brown bark or pale bark). This variety was grown at an elevation of 6,000–2,000 ft. in the Nilgiris near Ootacamund and in Ceylon, but was found unsuitable for the climate of Sikkim. The total alkaloidal content in this variety is very large and of late years the quinine yield has considerably increased. It produces the Crown or Loxa bark of commerce.

C. calisaya Wedd. This produces the yellow bark and is largely grown at an elevation of 1,500 to 3,000 ft. above the sea level. It is found in the Mayor valley in the Nilgiris and in Sikkim. 1,000 gm. of good calisaya bark yield 60 gm. of total alkaloids containing 30 gm. of quinine sulphate. This variety may be said to have also succeeded well under Indian climatic conditions.

C. hybrida or ledger hybrid (*C. ledgeriana* \times *C. succirubra*), is hardier than *C. ledgeriana* and is cultivated in a few areas in Bengal. *C. robusta* (*C. officinalis* \times *C. succirubra*) is grown at Naduvattam in Madras at an altitude of 3,500–6,000 ft. It forms 22 per cent. of the trees in Indian plantations. Another hybrid (*C. officinalis* \times *C. ledgeriana*) is grown in Mungpoo.

C. ledgeriana Moens., the source of Ledger bark, is a weak, straggling but fast growing tree, attaining a maximum height of about 20 ft. It is considered by some authorities to be a variety of *C. calisaya*. It has smooth, thick, elliptical leaves, yellowish flowers and ovoid-lanceolate capsules (8–13 mm. long). It flourishes at altitudes of 3,000–6,000 ft. It is grown in Bengal practically to the exclusion of other species (3,634 acres out of 4,382 acres in 1948–49 were under *C. ledgeriana*). It is also grown on the Anamalai hills and in Tinnevely district in south India. The plantation in Khasi and Jaintia hills (5,000 ft.) was expected to be ready for harvesting in 1952. The bark contains a high percentage of quinine (up to 14 per cent.) but the species is difficult to rear and is exacting in its requirements. It forms 72 per cent. of the cinchona trees in Indian plantations.

These are the important species of cinchona plants grown in India, for the supply of the local demands and the yield of the bark from these sources has been kept up at as high a level as possible in spite of the many difficulties.

CULTIVATION.—Cinchona particularly *C. ledgeriana*, thrives best in a tropical climate at altitudes of 3,000–6,000 ft. A fairly high average temperature (60–75°F.) with a small range of variation, high atmospheric humidity, a high rainfall (100–150 in.) well distributed throughout the year, and a light, well-drained virgin forest soil rich in organic matter with no possibility of sub-soil water-logging, are required. Cinchona prefers acidic (pH., 4.2–5.6) soils. A nitrogen level of about 0.8 per cent. in the top one foot and not less than 0.1 per cent. in the third foot of soil, is necessary for successful growth. A sloping situation sheltered from wind is preferred. Cinchona is known to grow in some regions of Madras where the annual rainfall is 45 in. and considerable periods of drought occur. In India it is cultivated in Bengal and Madras.

PROPAGATION.—Cinchona is propagated either by seeds or by vegetative methods. All known species of cinchona are highly heterozygous and vegetative methods offer the only means by which the performance of selected strains can be ensured in the progeny. Propagation by seed is the method commonly adopted in India, as it is comparatively less expensive, and the seeds of even the best varieties are easily available. The seeds are small and light, about 98,000 weighing 1 oz. Seedlings are raised in sloping beds, 12 ft. \times 4 ft., covered by a thatch roof. The top layer, up to a depth of 2–3 in., is composed of a mixture of leaf mould and sand in equal proportions, and is carefully pressed by hand so that it is uniformly firm all over. On no account should cattle manure be incorporated in the soil of either the seed bed or the nursery bed. Seeds are sown as early as possible after collection as their viability suffers on storage. They are not scattered thickly on the surface, fine sand sprinkled over to keep the seeds

The reason for the low production of quinine in India was the small area under Cinchona cultivation. The acreage under cinchona in Government plantations of Bengal and Madras is given below. In addition there are about 38,000 acres of land reported as suitable for cinchona plantations:—

YEAR	TOTAL ACREAGE	YEAR	TOTAL ACREAGE
1939-40	5322.10	1944-45	7644.07
1940-41	5437.59	1945-46	9237.63
1941-42	5607.59	1946-47	10537.73
1942-43	5955.97	1947-48	11777.53
1943-44	6508.69	1948-49	13017.13

QUININE REQUIREMENTS OF INDIA.—That quinine is one of the most needed drugs from the point of view of the Indian public is obvious from the fact that it is used in the prophylaxis and treatment of malaria, the most widespread disease in the country. The high incidence of this malady is sufficient ground for a demand for an adequate supply of this valuable drug. It has been estimated that there are in India 10,00,00,000 untreated sufferers from malaria and a little over 80,00,000 receiving complete or partial treatment. These figures, though not necessarily accurate, are, however, sufficient to show to what an extent the people suffer from that disease. In addition to the high mortality there is the incapacity to individuals, both temporary and permanent. The economic loss and the consequent penalty which has to be paid by the country as a whole, is tremendous. As regards the question of production of quinine, India still produces less than half the amount of quinine annually consumed by her population. Out of the total of 2,00,000 lb., 1,10,000 lb. are imported and only 90,000 lb. are produced in India. According to Krishnan, the amount imported is 1,40,000 lb. and the amount produced is 70,000 lb.

The production of a number of effective synthetic antimalarial drugs has altered the position with regard to quinine. Large quantities of these are imported into India every year. It may be stated, however, that quinine still compares favourably with the synthetic antimalarial drugs so far as its effects in controlling the symptoms of an acute attack of malaria are concerned. It should be remembered, however, that none of the synthetic antimalarial drugs are at present produced in India. In times of emergency such as war, therefore, if the foreign supplies are cut off, India will have to rely chiefly on cinchona alkaloids for treatment of malaria. It has, therefore, been urged that the plantations should be kept going if not enlarged. The National Antimalaria Control, recently started, has already afforded protection to 100 million of the population and in due course such protection will be extended throughout the country. This will naturally largely decrease the requirements of antimalarial drugs of all descriptions.

Alkaloids of Cinchona Bark other than Quinine

It is unfortunate for India that of all the alkaloids of cinchona bark the merits of quinine alone should have been recognised by the medical profession.

A reference to the history of the treatment of malaria in a published work by Lieut.-Col. R. Knowles and Senior-White, shows that this routine use of quinine sulphate is more or less an accident and that "it is very far from certain that quinine is the best alkaloid of cinchona bark to use. Both quinidine and cinchonidine are more efficacious with regard to their antimalarial power". The important investigation carried out by Fletcher in Kuala Lumpur in the Malay States and the experience at the Calcutta School of Tropical Medicine show that alkaloids of cinchona bark other than quinine are quite effective in the treatment of malaria, if given in the usual doses in which quinine is given. The total alkaloids of the bark in the form of cinchona febrifuge have been used in the Carmichael Hospital for Tropical Diseases and at the out-patient department of the School for many years with very satisfactory results. It would appear that the efficacy of the other alkaloids of quinine in the treatment of malaria has not been sufficiently recognised by the medical profession. Even if their efficacy against malaria does not quite come up to that of quinine, it will be worth while to have them. Let quinine stand as the remedy for malaria for those who can afford to buy it, but let the total alkaloids, be made available to satisfy the requirements of the masses at a price which they can afford to pay.

CHEMISTRY OF CINCHONA BARK.—The most important alkaloid of cinchona is quinine. In addition, more than twenty other alkaloids have been isolated from cinchona of which cinchonidine, quinidine and cinchonine are important. The alkaloids exist chiefly as salts of quinic and cinchotannic acids, and their relative concentrations vary in different species. The major alkaloid of *C. ledgeriana*, *C. calisaya* and *C. officinalis* is quinine, while that of *C. succirubra* is cinchonine. In individual plants the total alkaloid content increases up to the age of 8 to 12 years, and then begins to decrease. The alkaloids are formed during the descent of the sap, and their concentration is low in the twigs and increases down the stem to a maximum in the root bark. In *C. ledgeriana*, almost 90 per cent. of the total alkaloids of the stem bark is quinine, while of the total alkaloids of the root bark, only about 60 per cent. is quinine. The leaves contain about 1 per cent. total alkaloids. In the early years of planting in the Far East, the total alkaloids of *C. succirubra* were used for medicinal purposes under the name of Quinetum. In India, when *C. succirubra* was replaced by other species, quinetum was gradually replaced by Cinchona Febrifuge consisting of the residual alkaloids left after the removal of quinine. The Malaria Commission of the League of Nations redefined quinetum as a mixture of equal parts of quinine, cinchonidine and cinchonine, and introduced a new product called Totaquine or Totaquina which is defined in the B. P. as containing not less than 70 per cent. of crystallisable cinchona alkaloids—quinine, cinchonidine, cinchonine, and quinidine—of which not less than one-fifth is quinine. Cinchona febrifuge varies greatly in physical characters and composition for use as an antimalarial drug, it should be of the same standard as totaquina. Quinine and quinidine are isomeric and are respectively leavo- and dextro-rotatory. They differ from cinchonine and cinchonidine in possessing a methoxyl group. Empirically, quinine

may be regarded a methoxy cinchonidine and quinidine as methoxy cinchonine. The scission products of the principal alkaloids fall into two classes, viz., derivatives of quinidine, and derivatives of a heterocyclic ring system, formerly referred to as the 'second half' of the molecule. The second half has the same structure in all the four alkaloids. The complete synthesis of quinine was announced in 1945.

In Table V, the proportions of the important alkaloids occurring in the bark of the roots, stems and branches of the important species of cinchona grown in India (Mungpoo) are given.

TABLE V

		Quinine	Cincho- nidine	Quinidine	Cinchonine	Amorphous	Total
Per cent.							
<i>C. ledgeriana</i> —							
Root	{ in Bark ...	5.11	0.44	0.53	0.68	0.71	7.47
	{ of Alkaloid ...	68.4	5.9	7.1	9.1	9.5	
Stem	{ in Bark ...	4.14	0.36	0.44	0.25	0.60	5.79
	{ of Alkaloid	71.5	6.2	7.6	4.3	10.4	
Branch	{ in Bark ...	1.98	0.09	0.14	0.20	0.57	2.98
	{ of Alkaloid	66.4	3.1	4.7	6.7	19.1	
<i>C. Hybrid</i> —							
Root	{ in Bark	3.10	0.63	0.50	1.22	0.69	6.14
	{ of Alkaloid	50.5	10.3	8.1	19.9	11.2	
Stem	{ in Bark ...	2.87	0.33	0.34	0.46	0.54	4.54
	{ of Alkaloid	63.2	7.3	7.5	10.1	11.9	
Branch	{ in Bark	1.79	0.21	0.29	0.44	0.66	3.30
	{ of Alkaloid ...	54.2	6.4	6.2	13.3	20.0	
<i>C. Officialis</i> —							
Root	{ in Bark	1.76	0.49	0.52	0.66	0.63	4.16
	{ of Alkaloid	42.3	11.8	14.9	11.9	15.1	
Stem	{ in Bark	2.56	0.89	0.13	0.37	0.47	4.42
	{ of Alkaloid ...	57.9	20.2	2.9	8.4	10.6	
Branch	{ in Bark ...	1.44	0.49	0.09	0.19	0.14	2.35
	{ of Alkaloid	61.3	20.8	3.8	8.1	6.0	
<i>C. Succirubra</i> —							
Root	{ in Bark	1.42	1.12	0.37	3.00	1.30	7.21
	{ of Alkaloid	19.7	15.5	5.1	41.7	18.0	
Stem	{ in Bark	1.74	1.47	0.20	1.63	1.05	6.09
	{ of Alkaloid	28.6	24.1	3.3	26.8	17.2	
Branch	{ in Bark	1.16	0.82	0.20	1.10	0.72	4.00
	{ of Alkaloid	29.0	20.5	5.0	27.5	18.0	

TOTAL ALKALOIDS OF CINCHONA BARK: CINCHONA FEBRIFUGE.—The term 'cinchona febrifuge' is rather vague. The total mixed alkaloids of *C. succirubra* were called 'cinchona febrifuge' prior to 1903. After that date it represented a mixture of residual alkaloids remaining after extraction of quinine from the barks of *C. ledgeriana* and its hybrid *C. succirubra*, a certain amount of quinine being added to make it approximately similar to the original cinchona febrifuge in composition (Gage). This is sold to the public in the form of powder and tablets in India, its price being lower than that of pure quinine. As met with generally, it appears to consist of any mixture of the bark extracts and by-products of quinine manufacture which makers wish to get rid of. Some of these mixtures are of excellent quality and contain a large percentage of the alkaloids, and are considered by many experienced physicians to be therapeutically as good as quinine; others are decidedly inferior and contain small proportions of the alkaloids. The composition and the variations in the alkaloidal contents of different specimens which have been analysed are stated below:—

Quinine	....	....	....	2.7 to 15.5 per cent.
Cinchonidine	....	....	....	3.4 to 35.0 " "
Cinchonine	....	....	....	18.6 to 33.5 " "
Quinidine	....	....	....	4.5 to 22.8 " "
Amorphous alkaloids	....	....	....	17.0 to 54.9 " "

EFFICACY OF OTHER ALKALOIDS.—Experiments carried out by Goodson, Henry and Macfie (1930) in bird malaria have shown that of the cinchona alkaloids the most active was quinine, followed by quinidine, quinine, cinchonidine and cinchonine in ascending order, though there is little to choose among the last four. Dale and James (1925) found the curative effects of quinine, quinidine and cinchonine the same on all forms of malaria, and except for the depression caused by the last, no difference in toxicity. Ciuca made similar comparative tests with quinetum and found it to be as effective as pure quinine hydrochloride. It would appear from this that, so far as the action of the crystalline alkaloids of cinchona bark on malaria and their selective action on benign and malignant tertian parasites are concerned, there is very little to choose between them. Fletcher's conclusions regarding the toxicity of quinidine are not borne out by our experience. It is liable to produce depression of the heart and faintness, and sudden deaths have been known to occur, especially in those suffering from emaciating diseases such as kala-azar. It is evident from the above that much waste has resulted in using only pure quinine, and the cheaper and equally efficacious alkaloids might well be substituted in the treatment of ordinary cases of malaria, while the more expensive and refined alkaloid may be reserved for severe types of cases. In strictly controlled tests it has been found that in dosage of 0.1 gr. per kilo. of body weight, cinchona febrifuge was less satisfactory than quinine, but when 0.1 gr. per lb. was given both were equally effective. Any of the preparations such as cinchona febrifuge, quininum and quinetum may be used, provided the amount of the total crystalline alkaloids present is known so that the proper dosage required can be given. For instance if the total

crystalline alkaloids present are 70 per cent. or thereabout, it will be known that 10 gr. of it are equal to 7 gr. of quinine. If this is not considered desirable, the sulphate of the total alkaloids of the bark may be used.

Cinchona febrifuge has been very largely used of late years in the treatment of malaria all over India with very gratifying results. The mixture used in the Carmichael Hospital for Tropical Diseases, Calcutta, is as follows:—

<i>Cinchona febrifuge</i> (Indian)	.....	.....	.....	10 gr.
Citric acid	.....	.....	.....	20 "
Magnesium sulphate	.....	.....	.....	20 "
Extract of liquorice	.....	.....	.....	1 dr.
Syrup of Virginian Prune	.....	.....	.....	10 min.
Syrup	} equal parts	.....	.....	$\frac{1}{2}$ oz.
Water		.....	.....

Dose.—1 oz. three times a day, two and a half hours after food for one week; thereafter twice a day for 24 days. It is liable to produce nausea and vomiting as the amorphous alkaloids present stick to the mouth. The majority of patients, however, tolerate it well if it is taken at the right time, i.e., 2½ hrs. after food when the stomach is empty. If nausea and vomiting occur, a dose of 15 min. of 1 in 1,000 adrenaline or a min. of tincture of iodine in a little water before the *cinchona febrifuge* will check the vomiting. If necessary 5 to 10 min. of tincture of opium may be given. Fletcher (1925) came to the conclusion that *cinchona febrifuge* with 7 to 10 per cent. of quinine was therapeutically as efficient as quinine, in doses of 10 gr. twice a day, and it is no more toxic.

Galenicals of *cinchona* are used as bitter tonics and stomachics. On account of the astringent action, a decoction and acid infusion are some times used in gargles. Quinine and totaquine are widely employed, particularly for malaria and although partly replaced by synthetic drugs, they are likely to be used in considerable quantities for many years. Where treatment of malarial population must be carried out without sufficient medical supervision quinine rather than mepacrine is advocated. Quinidine is employed in auricular fibrillation.

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CINNAMOMUM CAMPHORA (Linn.) Nees & Eberm. (Lauraceæ)

CAMPHOR TREE

VERN.—*Kapur, Karpur, Karpuram.*

Camphor is one of the most common remedies and is used in almost every house in India for a variety of purposes. For her requirement of camphor, India is practically completely dependent on foreign countries. China, Japan, Formosa, and Borneo camphor find a ready market in India. The camphor tree is a large handsome evergreen tree, native to China, Japan and Formosa, and introduced

into and cultivated in many other countries including India, either as an ornamental plant or as a source of camphor. In its natural habitat it attains a height of 100 ft. and a girth of 6-8 ft. In India, however, its growth is stunted. *C. camphora* comprises many forms, some of them morphologically not differentiated but physiologically distinct. A few contain camphor while others produce only an aromatic oil. Non-camphor plants, apparently resembling *C. camphora* in morphological characters have been described as separate species, but the predominant opinion is that they are merely forms. Camphor is formed in the oil cells distributed in all parts of the tree. These cells begin to form early in the growth of the plant organs and are filled with a yellow oil from which camphor is slowly deposited. The formation of camphor is brought about through the agency of an enzyme present in the growing parts of the tree, particularly in the tissue within the cambium region. Each layer of wood, as it is formed, is enriched by camphor.

CULTIVATION.—The plant has been successfully cultivated in India at Dehra Dun, Saharanpur, Calcutta, Nilgiris, and Mysore. In the Nilgiris it does well upto an altitude of 7,000 ft. and in Ceylon upto 5,000 ft. It thrives best at elevations of 4,000-6,000 ft. provided the temperature does not fall below 15°F. Although the tree can be cultivated in all parts of India with an annual rainfall of 40 in. and over, its cultivation as a commercial enterprise is not likely to prove profitable outside the tropical areas, and even there, the financial returns are likely to be small. The plant is reported to thrive on poor laterite soil in the Federated Malay States. Observations in India, however, suggest that a fertile, well-drained, sandy loam is needed for its successful cultivation. Deeply tilled clay soils are also suitable, but they should be rendered porous by mixing leaf mould and sand. Addition of artificial fertilisers has also been recommended. Camphor plants can be raised from seed, layers, branch cuttings, and root-suckers. Propagation by seed is the normal practice. The seeds should be sown as early as possible after collection, in a nursery. The nursery beds are prepared from light, fertile, sandy loam and good drainage provided. The practice in the Hallakarai estate (Nilgiris) is to sow seeds thickly in raised beds heavily fertilised with *shola* soil and cattle manure. Six months after germination, the seedlings are transplanted into seed baskets filled with a mixture of equal parts of *shola* soil, well decomposed cattle manure, and sand. The ends of roots are cut off, as also the tops. It is necessary to fill in the soil until the stem is covered to the same level as in nursery beds. The seedlings are planted in the field in 2 ft. cube pits dug 6-12 ft. apart. Transplantation is carried out during January-February when seedlings are about one year old. The field is prepared by double ploughing in October-November and pits are dug in December. A spacing of 6-8 ft. each way is recommended. Wider spacing is considered wasteful. A spacing of 6 ft. each way accomodates about 1,210 plants per acre. The time for transplanting in Dehra Dun is July, when seedlings are either 4 or 16 months old.

PREPARATION.—The best yield of camphor is obtained from trees upwards of fifty years old, a fact which helps to explain the small quantities produced in many of the countries mentioned above where cultivation has only commenced during the present century. Parry describes the preparation of camphor as follows: "The tree is felled and the young branches and twigs are chopped up and packed in perforated jars, and heated over a crude steam-bath. The steam enters the jars, saturates the chips, and causes the crude camphor to sublime and condense in earthenware pots placed over the jars. The crude camphor is sent to the pot, and a certain amount of oil exudes from it which is collected and is known as oil of camphor. The majority of the oil is, however, produced by distilling the chips with water in crude stills. The crude product amounts to about 3 per cent. of the wood used. The oil is drained from the crystalline camphor, of which it retains a considerable amount in solution. This is transferred to a still, and about two-third is distilled off, leaving the bulk of the camphor in the residue, which is cooled and pressed to separate more camphor. This process is repeated so long as it pays, and the residue forms the camphor oil of commerce." The crude camphor is refined by sublimation, generally with quicklime and charcoal. Formerly, camphor oil was regarded as having no value. Today, however, it is used to an enormous extent in the preparation of safrol, which is used as a cheap perfume, for the manufacture of artificial oil of sassafras, and for the synthesis of heliotropin. Camphor is refined in Japan, Europe, and the U.S.A. from the crude product, which contains about 90 per cent. of camphor. It is sublimed into large chambers where it is condensed into small crystals (flowers of camphor). From these the familiar blocks are made by hydraulic pressure. Trials carried out at Dehra Dun show that camphor can be obtained by the distillation of leaves, although as a commercial venture the yield is stated to be uneconomical. The concentration of camphor varies in different parts of the tree. It is maximum in the underground roots. The following statements will indicate the percentage contents of camphor oil and camphor in different parts of the tree grown in different places in India:—

Camphor Content of Different Parts of the Camphor Tree Grown in India

PLACE OF GROWTH	DESCRIPTION OF MATERIAL	TOTAL VOLATILE OIL YIELD PER CENT.	CAMPBOR PER CENT.	CAMPBOR OIL PER CENT.
Nilgiris	Green Leaves	1.0	0.1—0.7	0.9—0.3
Madras	do	2.62	1.99	0.63
Burma	do	1.51	1.03	0.48
Cochin	do	2.33	2.01	0.32
Dehra Dun	do	4.04	0.38	3.66

Camphor oil is the residue left after camphor sublimes over.

CAMPBOR PRODUCTION IN INDIA.—As long ago as 1896, Hooper distilled camphor leaves grown at Ootacamund, obtaining from 50 lb. about 1 per cent. of oil containing 10 to 15 per cent. camphor. The possibilities of camphor cultivation

tion in northern India have been extensively studied by Howard, Robertson and Simonsen and their researches have been published in the Indian Forest Records, 1923. Natural camphor is not produced to any considerable extent in India. An area of about 8 acres in the Hallakara estate in Nilgiris carrying plants 20–60 years old, are intermittently exploited for camphor. The yield of camphor is about 1 per cent. on the weight of the leaf. The annual production in Hallakara estate is about 500 lb. of camphor and 150 lb. of camphor oil, both products having a ready market. The yield is about 60 lb. camphor and 10 lb. camphor oil per acre though under favourable conditions a yield upto 180 lb. per acre may be expected. In U.S.A. the estimated yield of camphor is 125–150 lb. per acre and in Algerian plantations 268 lb. In Ceylon plantation the estimated yield per acre is 120–130 lb. of distillate.

OTHER POSSIBLE SOURCES OF CAMPHOR.—Camphor is also obtained from the oil distilled from the leaves of certain species of *Ocimum* or Camphor Basil, especially *O. canum* and *O. kilimandscharicum*. *O. canum* grows fairly extensively in southern U.S.S.R., where about 20 tons of medicinal camphor are stated to have been produced in 1936. The volatile oil from *O. canum*, which grows wild in north India, does not contain any camphor. *O. kilimandscharicum* has been reported to contain 5 per cent. of essential oil containing 47–74 per cent. camphor. Experiments were conducted in the United States of America during the last War on the cultivation of this plant. The Forest Research Institute, Dehra Dun, has undertaken the experimental cultivation of *O. kilimandscharicum* with seeds obtained from Kenya with a considerable measure of success. A number of other plants give products which are but slightly different from Japan camphor. *Dryobalanops aromatica*, indigenous to Sumatra and Borneo, yields borneol (Bornyl camphor or Borneo camphor). It is used in medicine and perfumery. Blumea camphor or Ngai camphor is obtained from *Blumea balsamifera*. It is similar to Bornyl camphor but is laevo-rotatory. Some of the Blumeas growing in India have been worked out. *Blumea balsamifera* DC. has been reported to yield 0.1 to 0.4 per cent. essential oil which is the source of Ngai camphor in Philippines. The yield from the same plant of Burmese origin cultivated in India has been recorded at 1.9 per cent. (on dry weight). *B. densiflora* DC., *B. eriagtha* DC. and *B. malcolmii* Hook. f. contain camphor in their essential oils. *B. lacera* DC. yields 0.085 per cent. essential oil containing Blumea camphor. In California camphor is produced from some species of *Artemisia* (Compositæ).

Synthetic camphor was produced commercially first in Germany during World War I. It is now produced in England, France, Russia, Switzerland, Italy, Spain, and the United States of America. In 1930, Germany produced 13 million lb. of synthetic camphor. The largest producer of synthetic camphor since 1933 is U.S.A. The oil of turpentine obtained from *Pinus longifolia* (chir pine) occurring in India is poor in α -pinene (25 per cent. as compared with 60–70 per cent. in French and American oils obtained from *P. pinaster* (*P. maritima*) and (*P. palustris*)). For the economic production of synthetic camphor, it would be necessary to select a source containing a minimum of 60 per cent. α -pinene,

and the oil from *P. longifolia* is considered to be unsuitable. Two other Indian species, *P. excelsa* (Himalayan blue pine) and *P. khasya*, are good sources of α -pinene, but the regions of their occurrence are inaccessible and commercial production of oil from these sources has not been possible so far. It is, however, possible to import α -pinene at economic prices from U.S.A. So long as α -pinene is available at economic rates, manufacture of synthetic camphor will be profitable, and the possibilities of manufacturing the product in India deserve consideration.

TRADE.—The world's annual camphor production from natural resources is about 5,000 tons in normal conditions. Before World War II, Japan, which was in possession of Formosa held monopoly of the natural camphor industry accounting for 80 per cent. of the world supply. During the War the industry suffered considerably and after the cessation of hostilities, Formosa was returned to China. The World production of synthetic camphor is also very much the same as that from natural camphor. The fate of camphor industry may approach that of indigo which was formerly a very thriving industry but has been blotted out of existence by production of aniline dyes and synthetic indigo. India's requirements of camphor are met largely by imports. The following data relate to imports of camphor into India:—

	QUANTITY LB.	VALUE RS.
1934-35—1938-39	19,46,899	21,90,116
1939-40—1943-44	7,41,663	14,62,602
1944-45	1,00,964	1,98,454
1945-46	4,42,514	7,74,990
1946-47	3,49,705	14,17,754
1947-48	16,74,904	45,64,520
1948-49	12,38,613	23,37,761
1949-50	13,40,307	23,96,204

Prices of camphor were subject to wide variation before the rise of the synthetic camphor industry. Prices of natural camphor follow those of synthetic camphor which in turn depend on prices of turpentine.

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CINNAMOMUM TAMALA Nees & Eberm. (Lauraceæ)

INDIAN CASSIA LIGNEA

VERN.—Sans.—*Tamalaka*, *Tejpatra*; Hind. and Beng.—*Tejpat*; Guj.—*Tamalapatra*; Tam.—*Talishappattiri*; Tel.—*Talisapatri*.

This is a moderately sized evergreen tree growing wild in tropical and sub-tropical Himalayas, Khasi and Jaintia hills and in East Bengal. This species is the source of Tejpat leaves used extensively in northern India as a spice. The bark of the tree, known in trade as Indian Cassia Bark or Indian Cassia Lignea, is collected from trees growing at the foot of Sikkim Himalayas. Tejpat is grown mainly in the Jaintia parganas of Sylhet district. Many plantations in this tract are self-sown and a few are planted. The total area covered is approximately 600 acres.

The bark is coarser and is sold in larger pieces than the true cinnamon or bark of *C. zeylanicum* for which it is often used as an adulterant. The outer bark of the plant yields on distillation an essential oil which has a pale yellow colour. Cinnamic aldehyde is the chief constituent of cassia oil and is contained in the commercial varieties to the extent of 70 to 85 per cent. Although this aldehyde is also the chief constituent of Ceylon cinnamon bark oil, there is an enormous difference between the odour and flavour of the two. In cinnamon oil, the associated materials, e.g. pinene, nonyl aldehyde, etc., have a fragrant and a delicate odour, but in cassia oil, the cinnamic aldehyde is overpowered by the terpenes, etc., which impart a somewhat disagreeable odour to the oil. A considerable trade is done in Bombay in cassia bark and oil, but these are mostly re-exports and not true exports. Definite information regarding the Indian trade in *C. tamala* cannot be obtained but it seems probable that very little if any of the truly Indian bark is exported. The trade in cassia oil has declined appreciably with the advent of the synthetic cinnamic aldehyde on the market and the adulteration of the oil with cheap terpenes. The leaves are used mainly as spice. In Kashmir they are used as a substitute for pan or betel leaves. In Indian cookery it takes the place of Bay leaves in Europe. It is used as a clarifier in dyeing with myrobalans or kamala. The leaves of *C. tamala* are carminative and are used in colic and diarrhoea. The oil from leaf resembles cinnamon leaf oil and contains d- α -phellandrene and 78 per cent. eugenol. The essential oil of commerce used in perfuming soap and in medicine, is derived from *C. cassia* and imported from China.

C. glanduliferum Meissn.—The Nepal camphor wood—is a large tree of the south Himalayas from Kumaon eastwards to Assam, the Khasia Hills and Sylhet. The bark of the tree is rough, pale brown, highly scented, with a strong smell of camphor when freshly cut. In the Indian Pharmacopoeia this plant has been recommended as worthy of more attention than has been hitherto paid to it. The wood and the leaves yield a crystalline product which has been shown by Schimmel & Co. to be d-camphor. It has been suggested as a substitute for oil of sassafras, which is obtained from the root of *Sassafras officinale*, a tree grow-

CITRUS AURANTIFOLIA (Christm.) Swingle (Rutaceæ)Syn. *Citrus medica* var. *acida*

THE LIME TREE

VERN.—Hind.—*Kaghzi nimbu*; Beng.—*Kaghzinimbu*, *Patinebu*; Guj.—*Khatalimbu*; Tam.—*Elumichai*; Tel.—*Nimma*; Kan.—*Limbe*, *Nimbe*; Mal.—*Erumi-chinarakam*.

CITRUS LIMON (Linn.) Burm. f. (Rutaceæ)Syn. *Citrus medica* var. *limonum*

THE LEMON TREE

VERN.—Hind.—*Baranibu*, *Jambira*, *Paharinimbu*, *Paharikaghzi*; Beng.—*Barancbu*, *Gorancbu*; Guj.—*Motulimbu*; Mar.—*Idalimbu*, *Thoralimbu*; Kan.—*Bijapura*, *Bijori*; Tam.—*Periya yelumichai*; Tel.—*Bijapuram*.

The recognition of the antiscorbutic properties of lime juice has made the fruit famous in therapeutics and in almost all countries it is considered to be a necessary adjunct to the ordinary diet. In medicine and perfumery, the lemon plays an important part. A pale yellow, bitter aromatic volatile oil is derived on expression from the fresh outer part of the pericarp of the fruit and is highly prized in medicine as a flavouring agent, carminative and stomachic. Lime is found growing wild in the warm valleys of the Himalayas. It is cultivated in the plains and up to an altitude of 4,000 ft. The small fruited kagzi is the variety grown all over India. A large number of types differing in size, shape and colour of the fruits are cultivated. With about 17,000 acres, Madras tops in the production of this fruit. Other producing areas are Bombay, Bengal, Punjab, M. P. Hyderabad, Delhi, Patiala, U. P., Mysore and Baroda. The lemon is popularly known as paharinimbu or jambir and though belonging to the same stock, differs from the lime fruit in being bigger in size with a rough, thin and loose rind. The wild stock of lemon tree is a native of the north-west regions of India ascending to an altitude of 4,000 ft. Lemon is cultivated in home gardens and small sized orchards in U. P., Bombay, Madras and Mysore. It is adaptable to a variety of soils and elevations. It yields prolific crops, both under irrigated and rain-fed conditions.

Considering the attention paid to the cultivation of these fruits in other parts of the world, very little seems to have been done to this industry in India. The lemon industry has flourished in Sicily and to a lesser extent in Calabria (Italy), but the tree also grows luxuriously in many parts of the world notably in Spain, Portugal, France, California, Florida, the West Indies and New South Wales. A large quantity of lime juice, lemon oil and other by-products, e.g. citric acid, citrus pectin, etc., are imported into India. On an average 1,000 to 1,500 gall. lemon oil are annually shipped to this country valued at Rs. 50,000 to 60,000,

Although no records are available regarding the amount of lemon juice cordial and other beverages containing these ingredients which are being received in all parts of India, there is no doubt that these form quite a large portion of the imports. The quality of Indian lemon peel is almost equal to the Sicilian variety and it has been estimated that if extraction of lemon oil is attempted from the Indian lemon peel, it will not be a failure commercially. The percentage of essential oil is less in lime than in lemon but the former is richer in juice and citric acid; the average amount of citric acid available from 100 c.c. of lime juice is about 5.9 per cent. whereas that obtained from the same quantity of lemon juice is 3.7 per cent. It will appear that the lemon-growing industry, if taken up on a sufficiently large scale, is very likely to pay its way. Lemon growing is not difficult. It requires a moist and sheltered climate with dry invigorating air and abundant sunshine—conditions which can be easily attained without much outlay of capital in many parts of India. The problem of proper and efficient irrigation of the soil can also be successfully met by proper selection of the locality. The well drained regions at the foot of the Ghat Hills have been suggested by certain agricultural experts and their possibilities in this direction deserve a thorough investigation. Indeed, the cultural conditions existing in India cannot in any way be said to be very much inferior to those prevailing in California, Florida and New South Wales where the citrus industry has recently established itself and made rapid advance. A perusal of the report of the California Fruit Growers Exchange, which controls the citrus industry there, shows what can be accomplished by co-operative efforts and by the application of modern scientific agricultural improvements. For nearly four months in the year the frosty climatic conditions prevailing in California are distinctly injurious to the lime crop. By heating up the orchards with artificial heat at the time of the frosts, the agriculturists obviate the risk of damage to their crops. If in these countries, in spite of the inclement weather, the lime and lemon industry can make such headway, it is difficult to understand why India should fail in raising citrus plantations on a large scale and in utilising the raw materials and by-products obtained therefrom.

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COLCHICUM LUTEUM Baker (Liliaceæ)

INDIAN COLCHICUM

VERN.—Sans.—*Hiranyatutha*; Hind.—*Hirantutiya*, *Surinjan*; Urdu—*Suranjanetalkh*; Punj.—*Surinjan-i-talkh*.

The corms and seeds of *C. autumnale* are official in the British Pharmacopoeia and are used extensively in Western medicine as a sovereign remedy for gout. This plant grows in the meadows throughout Europe but is not found in India.

Attempts have frequently been made to introduce this species into India but with very little success. Though the *C. autumnale* does not grow in India, a very good substitute in the form of *C. luteum* Baker, is available. It grows extensively in the western temperate Himalayas and is met with in open pasture lands or in the outskirts of forests extending from the Murree Hills to Kashmir and Chamba. It is a medicine of great repute in Afghanistan and northern India. A dark brown dry extract sold in small pieces prepared from the corm can be obtained from the drug-sellers in the bazar.

CULTIVATION.—For raising plants, seeds are sown under cover in beds or boxes from May onwards and lightly covered with soil. The seeds sometimes take a long time to germinate. Seedlings, when one year old, are transplanted 3 ft. apart in the field. Collection of corms may start when the plants are two years old. The corms are collected during June–July in the Kashmir valley, and in the hill ranges of Uri, Domel, Kishtwar and Badhrwah, the annual collection being estimated at 50–100 mds.

There are two varieties commonly sold in the Indian bazars; one is sweet and the other bitter. The bitter variety is *C. luteum* which contains the alkaloid *colchicine* in fairly large proportions; the sweet variety also contains traces of an alkaloid which has been found to be physiologically inactive. *C. luteum* or *Surinjan-i-talkh* is distinguished from the sweet variety *Surinjan-i-shirin* by its bitter taste, smaller size, darker colour and a reticulated appearance of the corms. The corms are somewhat conical or broadly ovoid or elongated and plano-convex in section, brownish to brownish grey in colour, and are either translucent or opaque. The flat side has a longitudinal groove. The surface is marked by indefinite and irregular longitudinal striations. The fresh corms usually measure 15–35 mm. in length and 10–20 mm. in diameter. The dried corm breaks easily with a mealy fracture, and the broken surface is white and starchy. The corm is odourless and possesses a bitter and acrid taste.

The medicinal properties of this plant were well-known to the Arabs. The Kashmir *Hermodactyls* or *Surinjan-i-talkh* was and is still used by the Mohammedan physicians as an alterative and aperient, especially in gout, rheumatism and diseases of the liver and spleen. In gout, it is combined with aloes; with ginger and pepper it is used as an aphrodisiac; a paste is made with saffron and eggs and is applied to rheumatic and other swellings; powdered root is sprinkled on wounds to promote cicatrisation. *Hiranya-tutha* or *Hiran-tutiya*, a medicine of great repute in Afghanistan and northern India, is a dark-brown dry extract prepared mainly from the aqueous extract of *C. luteum* and other species. In Hindu medicine *Tutham* or *Tuttanjan* is the term applied to a collyrium made of copper sulphate and root of *C. luteum*. The corms of *C. luteum* are occasionally adulterated with corms of the sweet variety and another plant, viz., *Narcissus tazetta*. This plant grows abundantly in Persia and is supposed to have similar properties. A variety known as *C. speciosum* Stev., commonly grows in Badghis and Khorasan and finds its way into India. The seeds of *colchicum* are not commonly sold in the Indian bazars. According to Dymock, Warden and Hooper (1893), the ether extract, i.e., the alkaloid-containing part, was 1.31 per cent. in bitter 'surinjan' obtained from Lahore and 0.69 per cent. in sweet 'surinjan' (*Merendera persica*) from Persia. The corms of *C. luteum* have been examined at the Calcutta School of Tropical Medicine and they appear to resemble *C. autumnale* in their general form.

Chemical analysis shows that they contain a large amount of starch, a small quantity of oily resinous matter and a bitter alkaloid. Following the assay methods laid down in the United States Pharmacopoeia, the percentage of the alkaloid in the air-dried corms of *C. luteum* was found to be from 0.21 to 0.25 and in the seeds from 0.41 to 0.43 per cent. The alkaloid thus obtained has the same properties as that of the official alkaloid colchicine obtainable from the official *C. autumnale*. The U.S.P. requires 0.35 per cent. of alkaloid in the corms and 0.45 per cent. in the seeds. No standard, however, has been fixed by the British Pharmacopoeia; it is merely recommended that the seeds should be employed for the preparation of the tincture and the corm for the extract or wine of colchicum. The alkaloid colchicine is liable to be affected by high temperature. The corms should, therefore, be collected early in the summer and dried at a temperature not exceeding 65°C. Attention to this direction may increase the percentage of the alkaloid. Dried seeds of *C. luteum* are brownish white, ovoid or irregularly globular (2—3 mm. diam.) odourless and bitter. They are medicinal, and used in the form of extract or tincture, for the same purposes as the corms. The seeds are not usually sold in Indian bazars. Indian colchicum corms contain abundant starch and the alkaloid, colchicine (0.21-0.25 per cent of dried corm). The seeds contain 0.41-0.53 per cent. alkaloid.

ACTION OF COLCHICINE.—The chief alkaloid colchicine, $C_{22}H_{25}O_6N$, occurs in the form of yellow flakes, crystals or as a whitish yellow amorphous powder, having a hay-like odour when damped and warmed. It has a very bitter taste, and darkens on exposure to light. It is hydrolysed by boiling with dilute mineral acids or alkalis yielding methyl alcohol and colchicine (C₂₁H₂₃O₆N). It has much the same type of action as colchicine, but the latter is more active and more toxic. When taken in large doses, colchicine causes intestinal pain, diarrhoea and vomiting. Galenical preparations of the crude drug and of colchicine itself, generally as salicylate, are used in the treatment of gout for empirical reasons based on clinical experience. In recent years colchicine has been widely used in plant breeding to induce polyploidy. Colchicine solutions of different strengths are used in this work, and the method and period of treatment vary for different plants. The alkaloid is reported to act on the spindle mechanism and arrest the separation of split chromosomes. It is also reported to markedly increase the susceptibility of cancer cells to X-rays, presumably due to its action on mitosis. It would appear from the above analysis that both the corms and the seeds of *C. luteum* or 'surinjan-i-talkh' sold in the Indian market could be used for therapeutic purpose in place of *C. autumnale*. This plant is now official in the Indian Pharmacopoeial list and a recognised substitute in British Pharmacopoeia.

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DATURA STRAMONIUM Linn. (Solanaceæ)Syn. *Datura tatula* Linn.

JIMSON WEED, STINK WEED, MAD APPLE, THORN APPLE, STRAMONIUM

VERN.—Sans.—*Dhattura*, *Ummatta*, *Kanaka*, *Shivapriya*; Hind., Beng., Mar., and Guj.—*Dhatūra*, *Sada dhutura*; Tel., Tam., Kan. and Mal.—*Ummatta*; Punj.—*Tattur*, *Dattura*.

Dhatūra was known to the ancient Hindu physicians. They regarded the drug as intoxicant, emetic, digestive and healing. Smoking of *datura* seeds as a treatment for asthma was known during the Vedic period. Its toxic properties were well-known and there is frequent mention in the literature of its use for suicidal and homicidal purposes. Dried leaves and seeds of *D. stramonium* are used in the British and the United States Pharmacopœias as antispasmodic in such conditions as asthma, whooping cough, etc. The active principles contained in the seeds and leaves are the alkaloids *hyoscyamine*, *atropine*, and *hyoscine*. *D. stramonium* is indigenous to India and grows abundantly throughout the temperate Himalayas from Kashmir to Sikkim.

CULTIVATION.—*Stramonium* prefers a rich calcareous soil. It can be grown from seeds sown in spring in drills, about 3 ft. apart; the plants are later thinned to stand 10 ft. apart in rows. The plant is sensitive to frost and sheltered situations are, therefore, preferred for cultivation. Entire plants are cut down when the fruits are mature but green, and partially dried in the sun or in the shade. The leaves are stripped and separately dried. The seeds are shaken off from the capsules when the fruits begin to burst. An outturn of 1,000–1,500 lb. of leaves and about 700 lb. of seeds may be expected per acre. Nitrogen manuring, which favours the growth of plants also favours alkaloid formation in the plant. Tetraploids produced by colchicine treatment contain more alkaloids than diploids.

The other species of *Datura* used in medicine in India are *D. innoxia* Mill. and *D. metel* Linn:

D. innoxia Mill. syn. *D. metel* Auctt. (non Linn.) is a coarse bushy annual attaining a height of 3–4 ft. It is a native of Mexico now found growing in the western parts of Deccan Peninsula and a few other places in India. It emits a rank, heavy, narcotic odour. It is used in India for the same purposes as *D. stramonium*. It is of interest as possible source of the alkaloid scopolamine used as a pre-anaesthetic in surgery and child birth, in ophthalmology and prevention of motion sickness.

D. metel Linn. syn. *D. fastuosa* Linn.; *D. alba* Nees; *D. fastuosa* var. *alba* (Nees) C. B. Clarke It is a sub-glabrous spreading herb, sometimes becoming shrubby. It occurs throughout India. The drug used in commerce is collected mostly from wild plants. The plant may be grown from seeds sown in June on the hills and in July in the plains. The yield of leaves and the alkaloid content are influenced by pruning and disbudding. Pruning has an adverse effect on height, leaf number, dry weight and alkaloid content; exfloration enhances their values. The principal alkaloid of *D. metel* is scopolamine. The dried leaves are

used in medicine for the same purpose as leaves of stramonium and belladonna. The green leaves are reported to be used in East Africa for dyeing cloth.

Seeds of *D. stramonium* var. *inermis* procured from Oxford (U.K.) were introduced in Jammu and Kashmir for experimental cultivation and the leaves collected from Jammu nursery showed 0.18 per cent. total alkaloids as compared with 0.29 per cent. at Yarikhah (7,000 ft.). The local plant of *D. stramonium* collected from Yarikhah showed 0.42 per cent. total alkaloids.

NOTE.—The equivalents for white or black in different vernaculars are usually prefixed to distinguish plants bearing white flowers from those bearing tinted flowers. It may be stated here that the colour of flowers is not a characteristic of the species, and plants of the same species may bear white, purplish or violet flowers.

CHEMISTRY AND USES OF *D. STRAMONIUM* AND *D. METEL*.—There are marked variations in the alkaloidal content of *D. stramonium* grown in different localities. These vary from 0.47 to 0.65 per cent. The mixed Indian seeds from *D. metel* give a total alkaloidal content of 0.23 per cent., consisting chiefly of *hyoscyamine* and *hyoscyne* in proportion of 2 to 1, together with a little *atropine*. The capsules contain 0.1 per cent. of total alkaloids consisting chiefly of *hyoscyne*. The seeds contain 0.216 per cent. of *hyoscyne*, 0.034 per cent. of *hyoscyamine*, and traces of *atropine*. The leaves and seeds of *D. metel* were made official in the Pharmacopoeia of India and galenical and other preparations like tinctures and plasters were frequently used. Both species which possess narcotic and anodyne properties, are useful in neuralgia and act as antispasmodics. *Datura* possesses properties analogous to those of belladonna. The leaves made into cigarettes are smoked to relieve asthmatic attacks. They are also used in the treatment of parkinsonism. Stramonium is administered in form of pills, tablets, tinctures and extracts. Stramonium ointment, containing lanolin, yellow wax and petrolatum, is employed in the treatment of haemorrhoids. The leaves are applied to boils, sores and fish-bites and the juice of the flowers is used for ear-ache. The juice expressed from the fruits is applied to the scalp for curing dandruff and falling hair. Stramonium is one of the chief ingredients of the Ayurvedic preparation, Kanaka Asava, used as demulcent, expectorant, antispasmodic and anodyne in coughs, asthma and phthisis. The seeds of *D. stramonium* have a more powerful effect than the leaves, but due to the presence of a large amount (16-17 per cent.) of fixed oil, it is difficult to obtain stable preparations from them. They have been employed for suicidal and homicidal purposes. The victim suffers from dryness of the throat, giddiness, hallucination and staggering; the voice is unrecognisable and the vision is affected; the patient lapses into coma which may end in death.

The upper leaves and branches are richer in alkaloids than those near the base. The total alkaloid content is considerably less after a rainy period than after clear weather. Indeed, the difference is so marked, that the drug, to be rich in alkaloids, needs to be collected in the early morning as it contains more alkaloids than those picked in the evening. The leaves dried in shade contain more alkaloids than those dried in the sun. Leaves which are allowed to dry on the plant contain more alkaloids than those dried after clipping; the increase is accompanied by a decrease in the alkaloid content of root and stem, suggesting a relocation. The alkaloid content of picked leaves, exposed to a temperature of 100°C. for 15 min. to destroy the enzymes as a preliminary to drying, is higher than that of leaves not so treated. The removal of flower buds increases the yield of leaves.

ECONOMIC ASPECTS.—There is a large demand for the preparations of *D. stramonium*. Besides the galenical preparations made from it, it is the main ingredient of cigarettes and the fumigating powders employed in asthma. The plant has been cultivated in America to get supplies for medicinal purposes. In view of the plentiful supplies met with in India it is surprising that most of the stramonium preparations and the alkaloids hyoscyamine and hyoscyne should be imported from outside. The alkaloidal content of *D. metel* is not low, and it grows so abundantly that it would be worth while using it in medicine, not only in the form of ordinary galenical preparations but also for extraction of the alkaloids hyoscyamine and hyoscyne. Small quantities of galenicals and tinctures are being produced in India and a firm in Calcutta is reported to be producing scopolamine hydrobromide but the quantity is too small for this large country.

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DIGITALIS LANATA Ehrh. (Scrophulariaceæ)

GRECIAN FOXGLOVE, WOOLLY FOXGLOVE

Digitalis is a genus of hardy herbs, native of Europe and Asia, some species of which are cultivated in many parts of the world. *D. purpurea* and *D. lanata*, two species of therapeutic value have been introduced into India and are cultivated for medicinal purposes.

D. lanata is a perennial or biennial herb, 2-3 ft. high, indigenous to central and southern Europe. It is now cultivated in England, U.S.A., and Canada. In India it is cultivated in Kashmir at altitudes of about 7,000 ft. This species thrives best on loamy soils and the method of cultivation is the same as that for *D. purpurea*. It is cultivated on a semi-commercial scale at Yarikhah (Kashmir). The output of dried leaves is about 240 lb. per acre per annum. The leaves of *D. lanata* produce the characteristic physiological effects of digitalis, the effect being considerably stronger and less cumulative. They are used as the source of digoxin, an active cardiac glycoside, not reported from any other species of the genus. Digoxin is official in some of the Pharmacopoeias.

CONSTITUENTS.—The fresh leaves of *D. lanata* contain 3 natural glycosides known as lanatosides A, B and C. Lanatosides A and B are closely related to the initial glycosides of *D. purpurea* known as purpurea glycoside A and B into which they may be converted by the elimination of an acetyl group. Lanatoside C when hydrolysed yields digoxin, the crystalline glycoside isolated by Smith in 1931, together with acetic acid and glucose. To extract the lanatosides, fresh leaves are ground with a neutral salt to inactivate the enzymes and the pulp extracted

with ethyl acetate. The glycosides are recrystallised from dilute alcohol. The product thus obtained is a mixture of lanatoside A (46 per cent.), lanatoside B (17 per cent.) and lanatoside C (37 per cent.). Digoxin is a white crystalline substance, sparingly soluble in water and chloroform, and soluble in dilute alcohol. It is separated from the total glycosides of the leaves by fractional extraction with boiling chloroform or ethyl acetate. The sparingly soluble fraction is crystallised from alcohol. On acid hydrolysis digoxin yields digoxigenin and digitoxose. Digoxin produces the same cardiac effects as digitalis. It is constant in potency and is quickly absorbed and eliminated. It is about 300 times more potent than Prepared Digitalis and is of particular value for rapid digitalisation. Oral administration, produces the characteristic digitalis effects on the heart within an hour and the maximum action is reached in 6 hrs. The response is prompt when injected intravenously, the onset of action being noticeable in 5-10 min., the maximum effect being reached in 1-2 hrs. As with digitalis, nausea, vomiting, and tachycardia may follow administration. The flowers and the seeds of *D. lanata* are physiologically active. The seeds contain 30 per cent. of a yellowish green, viscous, turbid fatty oil.

USES.—The leaves of *D. lanata* are used almost exclusively for the preparation of lanatosides and digoxin. The leaf can be grown in any quantity in the western Himalayas if the pharmaceutical concerns take up the manufacture of the digoxin and lanatosides. At present the glycosides are imported although the raw material is available in India.

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DIGITALIS PURPUREA Linn. (Scrophulariaceæ)

FOXGLOVE

D. purpurea Linn. commonly known as foxglove, is a biennial and sometimes perennial herb 2-6 ft. high, growing at altitudes of 5,000-6,000 ft. It was originally a native of western Europe but is now extensively grown in many parts of the world. There are a number of species having the same physiological action, though differing in their degree of potency. For instance, *D. purpurea* is more effective than *D. campanulata* or *D. alba*, but *D. ambigua* from Austria shows a therapeutic activity equal to *D. purpurea*. For many years, English-grown leaf was supposed to be the best in the market, but afterwards Germany and Austria have supplied large quantities of good leaf to the world. During the First World War the supply from the German sources was cut off and the Americans tried to develop their resources. In California, Oregon and Washington digitalis grows wild and the leaves collected from these plants were found to be active and of sufficient potency to allow their use for medicinal purposes. One of the American-grown species is *D. lutea* which, therapeutically, is as good as *D. purpurea*; in fact, it has the reputation of having much less toxic effects on the gastro-intestinal tract.

In India a large amount of digitalis is used every year. This can be judged from the fact that Messrs. Smith Stanistreet & Co., a firm of manufacturing chemists of Calcutta, writing in 1912 said that they alone could use 3 to 4 cwt. of the Indian-grown leaf if it was as active as the imported leaf. The consumption has gone up considerably since then. Some digitalis preparations used by the medical profession in this country are imported, and the problem has not only its economic aspect, but from the medicinal point of view the fact should be borne in mind that the digitalis preparations imported into India are liable to lose 20 to 40 per cent. of their potency in a very short time. The author and his co-workers some years ago investigated the properties of digitalis grown in India in order to see if the Indian leaf and its preparations could be advantageously substituted for the imported commodity. The result of this work has been that the Bengal Chemical & Pharmaceutical Works of Calcutta could use nearly a ton of leaf every year, all grown in India (Kashmir).

Before entering into a discussion of the therapeutic efficacy of the digitalis leaf grown in different places in India it will not, we think, be out of place to give a brief account of the cultivation, methods of collecting, drying and storage of digitalis leaf adopted in this country.

CULTIVATION OF DIGITALIS PURPUREA IN INDIA.—So far as is known none of the species of digitalis is indigenous to India but *D. purpurea* has long been grown in gardens in different hill stations as an ornamental border plant. As early as 1880 attempts were made to grow the plant in the Government gardens at Saharanpur and hill gardens in Mussoorie for a regular crop of leaves for medicinal purposes. The plant, however, did not flourish as it was reported to yield very few leaves and the cost of production was higher than that of the imported leaf. Systematic cultivation was, therefore, for the time being abandoned in these places. In the Kumaon gardens the plant did better and in 1912 leaves were examined chemically by Martindale and found to be well above the standard so far as the active principles were concerned. The plant was cultivated in other places and the cinchona plantation authorities at Mungpoo near Darjeeling (Himalayas) and also in Burma took it up. It was also introduced into the Nilgiri Hills and largely grown there from self-sown seeds, and the cinchona plantations supplied it to the Government Medical Store Depots at 3 annas per pound. As grown at Mungpoo it calls for very little attention in the matter of cultivation and grows well in open spaces at a height of 6,000 ft. above the sea level. Thousands of seedlings appear and nurseries for rearing are not necessary. Before planting a new block the ground is first cleared of jungle and dug to a depth of one foot. Then, with the aid of a rope, pegs are put in rows 2 ft. apart and 10,800 plants are planted per acre. The plants are grown for about 12 months, during which time it may be necessary to sickle the block twice and to hoe it once during the cold season. When grown in this way the plant does well and yields a good crop of leaves.

D. purpurea is now cultivated chiefly in Yarikhah, Tanmarg, etc., in Kashmir. Cultivation in Mungpoo (Darjeeling) and Nilgiri hills has been practically abandoned but the plant has become naturalized in these areas. Commercial cultivation in Kashmir was started about 20 years ago. Due to a fall in demand, cultivation received a set back and the average annual output had dwindled. Recently its cultivation on a commercial scale has been restarted at Yarikhah (Kashmir). Attempts to cultivate the therapeutically active plant on the plains of India have met with little success.

Foxglove is propagated by seeds collected from plants selected on the basis of high glycoside content of leaves. It is a calcifuge species growing well on light and sandy soils

containing traces of manganese. It prefers light overhead shade and is best cultivated in shady situations. The soil should be well-broken and liberally manured with leaf mould. The seeds are mixed with fine sand to ensure even distribution and sown in prepared nursery beds in March or April. Enough seedlings for planting an acre are obtained from 4-8 oz. of seeds. Seedlings, when 2-3 in. high, are transplanted in the field, preferably in damp weather, on ridges 2 ft. apart, the distance between plantings being 1.5 ft. In most areas where the plant is cultivated, seedlings from self-sown seeds are available in abundance and these are collected for planting in prepared ground. The crop is kept clear of weeds and the field is hoed once or twice a year. A balanced mixture of artificial fertilizers may be added for increasing the yield of leaves. The plant flowers about the end of April or early in May during the second year, followed by seed formation, after which the plant dies. Under favourable conditions, root stocks survive and plants may live for another year or two. Under cultivation, however, plants are uprooted after seed formation.

COLLECTION OF THE LEAF.—*Digitalis* usually begins to flower in India about the end of April and early in May; when the plants are in full bloom and two-thirds of the flowers on each spike are fully developed, leaf picking commences and goes on throughout the hot weather. In Europe and America the leaves are also collected throughout the summer from July to September when the plant is flowering. The best product is, however, gathered in the early part of the summer, about the month of June, just before the flowers have expanded. It was recommended that leaves should be collected from plants of the second year growth, but investigations have shown that first year leaves have the same glycoside content as those of the second year, and in India leaves are generally gathered from plants, irrespective of their age. The leaves are plucked by hand, being twisted or broken off without taking the thick fleshy leaf-stem. The lower basal leaves of poor colour are rejected, also the upper smaller leaves of the stem. Practically three-fourths of the total number of leaves per plant are taken, both young and old being mixed during collection. No particular attention is paid to weather conditions during the collecting period. It is at the beginning of the monsoon and the weather is usually dull and showery about that time. In Kashmir the collection is made from June to October from the first and second year old plants.

WITHERING AND DRYING.—Each day's collection of leaves in this country is spread in thin layers on bamboo 'machans' and left to wither for 36 hrs., being turned over occasionally to prevent fermentation. Finally, drying is completed in a 'sirocco' or oven at a temperature of 150°F. Without the use of the oven it would be very difficult to dry the leaves thoroughly during the monsoon. Drying in an oven, however, has been shown to cause a marked deterioration, especially if the temperature is allowed to run high. Our experience with Indian leaf is that sun- or air-dried leaves, such as those from Kashmir, retain activity very much better than the oven-dried leaves. The leaves are spread out in thin layers in the open air and take 7-10 days to dry in Kashmir.

STORING.—After drying, the leaves are stored in dark sheds. They are kept on the floor in a heap and covered with bamboo mats to exclude dust and light. Hatcher's work in America appears to show that no special precautions regarding storage, such as keeping the dried leaves in air-tight tins with a perforated bottom containing freshly burnt lime, are necessary in that country. In warm and moist climates, such as that of India, our experience is that unless such precautions are taken the leaf deteriorates in its therapeutic activity. *Digitalis* leaves kept in air-tight bottles in our laboratory kept their activity better than those left exposed to the moist air, especially during the hot weather. The quality of leaf obtained in Kashmir is as good as that imported from Britain or elsewhere. The leaf from Mungpoo is also of good quality but that from Nilgiris is reported to be inferior.

PHYSIOLOGICAL AND THERAPEUTIC ACTIVITY OF INDIAN LEAF.—In 1913, Dr. Gordon Sharp carried out a biological assay of *digitalis* grown in India. He found that the Indian-grown leaf on casual examination looked in every way like the ordinary wild or partially cultivated

variety grown in England and Germany. Their taste was equally bitter. On closer examination the Indian leaves had a coarser stalk and the venation was somewhat coarser. The leaves themselves were darker and tougher than the European leaves but not very different from wholly cultivated leaves grown in the south of England. The tinctures prepared from these leaves were darker and contained more resinous matter than those prepared from the British or German varieties. Mungpoo leaf gave good results by biological assay by the 'frog method' and by therapeutic trial on the human heart. Dr. Sharp pronounced that *D. purpurea* Linn. leaf grown in Mungpoo was at least equal in potency to British or German grown leaves. The leaf grown in the Nilgiris, however, failed to produce equally good effects. In 1920, Dr. Douglas Cow of the Pharmacological Laboratory at Cambridge, assayed tinctures prepared by Messrs. Smith, Stanistreet & Co., from the leaves grown in Mungpoo and in the Nilgiris with satisfactory results.

The specimens of leaf from Kashmir gave excellent results both by biological assay and clinical trials. In Kashmir digitalis is now grown on a large scale. The leaves are sun-dried and are packed in air-tight tins. Kashmir is not affected so much by the monsoon as the eastern Himalayas where Mungpoo is situated, and drying in the sun without the use of ovens is possible. The growing of digitalis in Kashmir has great possibilities. Freshly made tinctures from this leaf digitalised patients with 4 to 7 dr. per 100 lb. body weight.

VARIATIONS IN THE POTENCY OF DIGITALIS PREPARATIONS IN THE TROPICS.—A perusal of what has been said above, shows that digitalis leaf of good quality can be grown in some parts of India. This is of special importance in view of the observations by the author and his co-workers (1925-26) regarding the keeping properties of digitalis leaf and the preparations made from it in tropical climates. Biological assays were carried out by Hatcher's 'cat method' and the 'frog method' and chemical assays by 'Kundson and Dresbach's method'. As none of these methods gave a very accurate idea of the therapeutic activity of a preparation, clinical tests were also carried out with the same tinctures. The average dose of 15 c.c. (or $4\frac{1}{2}$ dr.) of the tincture per 100 lb. of body weight required to get the patient under digitalis effect in 36 to 48 hrs. is considerably increased if the tincture is deteriorated. By both these methods it was shown that the tinctures manufactured by reputed English and American firms showed in a very short time a reduction of 20 to 40 per cent. in their strength. Even fresh tinctures sent out soon after their manufacture and assayed soon after arrival seemed to deteriorate during transit. The deterioration is due to some change taking place in the digitalis glucosides, the nature of which is unknown. Such tinctures on dilution (1 in 10) become darkish in colour, unlike good tinctures which are light green and uniformly opalescent. These tinctures although they become more toxic when given to a cat intravenously and, therefore, having a smaller minimum lethal dose, are considerably weakened so far as their therapeutic activity is concerned. It has also been shown that fresh tinctures prepared from *D. purpurea* leaf grown in Kashmir or in Mungpoo showed their normal potency. Digitalis leaf also is liable to rapid deterioration if it is not properly cured and if it is badly stored.

USES.—Digitalis is used mainly for its effect on the cardiovascular system, increasing the force of systolic contraction and efficiency of the decompensated heart. It slows the heart rate and reduces cardiac oedema with diuresis. It is

used as myocardial stimulant in congestive heart failure, auricular flutter and auricular fibrillation. Digitalis has been recently shown to increase the coagulability of blood and to antagonise the anticoagulant action of heparin in the body. Its local effect consists in irritation, and an ointment of digitalis glycosides is said to be useful for cleansing wounds. In cases of burns, it is more effective than tannic acid or silver nitrate in preserving cells severely injured by heat. It is commonly administered in the form of tablets, powder or prepared digitalis tincture, cachets, suppositories and injections. In therapeutic doses, the drug usually produces mild toxic effects and it is necessary to regulate the dose in such a manner as to avoid these effects. The strength of digitalis preparations should be stated in terms of standard digitalis powder. For standardisation, Chopra's modification of Hatcher and Brody's cat method has given reliable results; the method enables the evaluation of both strength and toxicity. The toxic effects of digitalis include headache, fatigue, malaise, drowsiness, nausea and vomiting. Vision is often blurred. Sinus arrhythmia may occur early as a minor toxic effect. Paroxysmal auricular or ventricular tachycardia are particularly ominous and demand immediate cessation of the drug. Ventricular fibrillation is the commonest cause of death from digitalis poisoning.

CONSTITUENTS.—The active constituents of digitalis are the several glycosides. The concentration of the total active glycosides in the leaves is about 1 per cent. Three well defined crystalline glycosides, digitoxin, gitoxin and gitalin all possessing cardiac activity and originally thought to be natural glycosides, have been isolated from the leaves. Digitoxin and gitoxin are now known to be derived from purpurea glycoside A and purpurea glycoside B respectively, which are present in the leaf and which are hydrolysed by the enzymes present in the leaf into digitoxin and glucose, and gitoxin and glucose respectively. It is probable that gitalin is likewise a hydrolytic product of a natural glycoside present in the leaf. Digitoxin, present in the leaves to the extent of 0.2–0.3 per cent., is a colourless, odourless, intensely bitter, crystalline substance insoluble in water and soluble in alcohol and chloroform. It is the most potent of the digitalis glycosides, its activity being about 1,000 times that of powdered digitalis. It is rapidly and completely absorbed by the gastro-intestinal tract. Digitalin is an active cardiac glycoside present in the seeds of *D. purpurea* and formerly described under the name DIGITALINUM VERUM. It is present in the seeds (yield, about 0.3 per cent. as hexa-acetate) in association with large proportions of unidentified active glycosides, together with inactive saponins of which digitonin, gitonin and tigonin have been isolated. The seeds contain about 31.4 per cent. of an amber-coloured fatty oil with a bland taste.

Indian grown digitalis is rapidly replacing the imported digitalis. A number of manufacturing firms in India supply freshly prepared tincture from fresh leaf to their customers. Distinct advantage can be gained by using freshly made tinctures from freshly collected and properly dried digitalis leaf grown in India. Cultivation of digitalis in India on proper line has a great future. Experiments to raise better strains of digitalis seeds are being conducted at

Yarikhah Drug Farm (Kashmir) where a good quality of digitalis is grown for commercial purposes. Digitalis leaves raised from seeds obtained from U. K. and U.S.A. on biological assay showed 9 units per gm. as compared with 11.42 to 12.5 units per gm. of the local leaf against 12.5 units per gm. international standards. The output of the dry leaf from Kashmir is steadily increasing to meet the demand.

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ELETTARIA CARDAMOMUM Maton (Zingiberaceæ)

LESSER CARDAMOM, CARDAMOM

VERN.—Sans.—*Upakunchika, Ela*; Hind. and Beng.—*Choti elachi*; Mar.—*Veldode*; Guj.—*Elchi*; Tel.—*Yelak-kayalu*; Tam.—*Yelakkai*; Kan.—*Yclakki*; Mal.—*Yelam*.

The cardamom is a perennial plant with thick, fleshy rhizomes and leafy stems, 4 to 8 ft. in height with a long branched inflorescence which arises near the ground. It is indigenous to western and southern India, being found in the rich moist forests of Kanara, Mysore, Coorg, Wynaad, Travancore and Cochin; it is also cultivated there on the tea and rubber estates by both European and Indian growers. On the coffee estates of Coorg and Mysore it is grown in gullies and ravines, as it thrives best in such damp, shady places. It is also found wild in Burma and Ceylon, and also Cochin, China and Malaya Archipelago. Several varieties of the true cardamom are met with in the market.

VARIETIES.—*E. cardamomum* exhibits considerable variation under cultivation and the naming of commercial types after the places of production has led to confusion regarding the identity of the varieties. Two varieties based on the sizes of the fruits are recognised. They are: (1) *E. cardamomum* var. *major* Thw. comprising the "wild" indigenous cardamom of Ceylon or Greater Oblong Cardamom or long Cardamom and (2) *E. cardamomum* var. *minor* Watt (syn. *E. cardamomum* var. *minuscule* Burkill) comprising all the cultivated races, particularly those included under the names Malabar and Mysore cardamoms. Var. *major* is the more primitive variety from which the cultivated var. *minor* is derived. The latter is commonly grown in India. It includes a large number of races differing in the size of the plant, the nature of the leaf surface and the characters of flowering panicles and fruit capsules. All the varieties and races are interfertile and the observed variations are probably due to natural crossing.

Malabar cardamom is cultivated chiefly in Mysore and Coorg and to a limited extent in Travancore. The wild type in south India, with one doubtful exception is the Malabar cardamom. Mysore cardamom is considered more suitable for higher elevations than the Malabar cardamom, as it thrives well over a wide range of conditions and is not very exacting in its water requirements. It is suitable for extensive planting and is cultivated in the larger holdings of Travancore, Anamalai and Nelliampathy hills. Ceylon's indigenous cardamom is a robust variety common in the wet forests of Ceylon and has been introduced into India in recent years. In addition to the two main varieties, a few more have been recognised recently. A type designated as var. *mysorensis* is common throughout south India and is cultivated in some areas. Another type has been observed growing in cardamom estates in Manjarabad (Mysore State) and has been designated as var. *laxiflora*.

DISTRIBUTION.—Cardamom cultivated in India is concentrated mostly in those regions which form the natural habitats of these species, except for a small area in N. Kanara, where it is grown as a subsidiary crop in areca nut gardens. The important areas of cultivation are: N. Kanara in Bombay State; Shimoga, Hassan and Kadur districts in Mysore; hills of Coorg; northern and southern foothills of Nilgiris (Nilgiri and Malabar Wynaad) and Anamalai, Nelliampathy and Kodaikanal hills in Madras; and the Cardamom hills in Travancore-Cochin State. About 1,00,000–1,20,000 acres are annually cultivated under cardamom in the different states, of which nearly 50 per cent. lies in Travancore-Cochin, 23 per cent. in Mysore, 13 per cent. in Coorg and 13 per cent. in Madras. Besides India, Ceylon is the only large cardamom growing country (7,000 acres in 1938). Cardamom is cultivated to some extent in Central America, particularly in Guatemala.

USES.—Cardamom is an article of some commercial value. It is exported largely to foreign countries where it is used as a spice and as a flavouring agent. Cardamom is used as a spice and masticatory, and in medicine. Cardamom seeds have a pleasant aroma and a characteristic, warm, slightly pungent taste. They are used for flavouring curries, cakes, bread and for other culinary purposes, as also for flavouring liqueurs. In the Middle East countries, cardamom is used for flavouring coffee. In medicine, it is used as an adjunct to carminative drugs. It is official in the British and U. S. Pharmacopeias and used as an aromatic stimulant, carminative and flavouring agent. An oil is extracted from the fruits and is used both in pharmacy and perfumery. It occurs to the extent of 4 to 8 per cent. in the seeds and contains a considerable amount of terpinyl acetate; cineole, free terpineol and probably also limonene are present. The aqueous portion of the steam distillate of cardamom (from Saklespur) contained 0.5 per cent. of an essential oil with the following constants: sp. gr. 0.0920; n_D^{25} , 1.4606; and $[\alpha]_D^{25}$, 0; cineol content, 80 per cent. Borneol was identified in the oil obtained from the aqueous distillate of Malabar cardamom oil, but was absent in that of Mysore cardamom oil,

PRODUCTION.—The average annual production of cardamom in India ranges between 35,000 and 40,000 cwt. During the last few years, production has gone down considerably in some areas due to the incidence of thrips. The adoption of suitable control measures is reported to have improved the yields in many areas now. The export of cardamom from India increased from 2,705 cwt. in 1902–03 to 16,556 cwt. in 1919–20, after which it showed a sharp decline, but registered a gradual recovery, reaching 17,381 cwt. in 1939–40. There was a set back again during World War II, when the European markets were closed. Exports have been resumed since 1945–46. The principal importing countries before the war were Sweden, Germany, the U.K., the U.S.A., and Middle East countries. Arabia and Sweden have been the principal importers since 1947.

The spicy aromatic seeds of some species of *Amomum* also called Cardamoms are cheaper substitutes for the true cardamom (*E. cardamomum*) which they resemble. *Amomum aromaticum* and *A. subulatum* are cultivated in India.

Amomum aromaticum Roxb. (Zingiberaceæ). VERN.—Hind. and Beng.—*Morang elaiichi*; Mar.—*Veldoda*. The plant is indigenous to East Bengal and Assam and distributed to the surrounding areas. It is cultivated in the wetter districts of Bengal and Assam at the foot of Himalayas. The seeds are used as spice and are medicinal. They yield oil about 1–1.2 per cent. containing a large quantity of cineole. This oil does not possess the characteristic odour of cardamom.

Amomum subulatum Roxb. VERN.—Sans.—*Ela*; Hind. and Beng.—*Baraelachi*; Tam.—*Periya-yelakay*; Pers.—*Qakilah-kalan*. This species is cultivated in swampy places along the sides of mountain streams in Nepal, Bengal, Sikkim and Assam. The fruits which are dark red-brown globose capsules (1 in. long) contain several seeds in each cell held together by a viscid sugary pulp. They are commonly sold in bazar by shopkeepers. The seeds possess properties similar to those of true cardamom for which they are often substituted. They are used in the preparation of sweetmeats. An oil extracted from the seeds rich in cineole is used for flavouring purposes. Both in the Indigenous and Western medicine; the greater cardamom is used as a frequent adjunct to other stimulants, bitters and purgatives in the form of tincture or powder. To allay inflammation, the oil is sometimes applied to the eyelids.

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EPHEDRA GERARDIANA Wall. (Gnetaceæ) and Allied Species

VERN.—Punj.—*Amsania*, *Butshur*, *Chewa*.

Few drugs of recent years have attracted so much attention of the medical profession as *ephedrine*, the alkaloid from *E. sinica*, the Chinese plant *Ma Huang*. A considerable volume of experimental work has been done on this subject and

a well compiled bibliography by Professor B. E. Read will interest those who wish for further details. The drug has been in use in China for the last five thousand years. The habitat of ephedra, however, is not confined to China but has a much wider geographical distribution. Liu has shown that it is scattered widely all over the world. In India a number of species grow abundantly in the drier regions of the Himalayas. A few species of ephedra also grow in the plains but these contain little or no alkaloid.

The plant has not been used in the indigenous medicine in this country. Although according to Aitchison some parts of *E. vulgaris* are used medicinally in Lahoul, the drug is not mentioned in the Ayurvedic (Hindu) or Tibbi (Mohammedan) medicine. It is said that one variety of ephedra, probably *E. intermedia*, is the famous 'soma' plant from which the favourite drink of the Rishis (ascetics) of the Vedic period was prepared, but there is little evidence to support this statement. The gradually increasing use of ephedrine in therapeutics and its high price induced the author (1926) to explore the resources of the Indian varieties of ephedra and to study their chemical composition, pharmacological action, and clinical uses. The sister alkaloid pseudo-ephedrine was also carefully investigated in order to see if any use could be made of it in therapeutics.

Chopra and his collaborators (1929) describe two varieties growing side by side on the mountain ranges bordering on the Jhelum valley. These varieties are of special interest on account of their high alkaloidal yield. The proportion of ephedrine and pseudo-ephedrine, however, in the two varies greatly:

(1) *E. vulgaris* or *E. gerardiana* is known in the vernacular as *Janusar*. It is a low, rigid, nearly erect shrub, usually 1 to 2 ft. in height. It occurs also in Hariab district, Kurram valley (at an altitude of 1,000 ft.), Himalayas (at an altitude of 8,000 to 14,000 ft.) also in the inner tracts in Sikkim ascending to an altitude of 16,500 ft. above the sea level. It has an alkaloidal content of 0.8 to 1.4 per cent., of which about half is ephedrine and the balance is pseudo-ephedrine. It may also be noted here that there are marked variations in the alkaloidal content of the green twigs and the stems of these varieties. The alkaloidal content of the green twigs of the Indian *E. vulgaris* is about four times that present in the stems and that of *E. intermedia* nearly six times.

(2) *E. intermedia* var. *tibetica* is known in the vernacular as *hum* (Trans-Indus). It is a small erect shrub. It occurs in the inner valleys of Chitral at an altitude of 4,000 to 5,000 ft. on the dry rocky slopes, in Gilgit, Zaskar, Upper Chenab, Kanawar (at 6,000 to 9,000 ft.) and also in Baluchistan. The variety *tibetica* gives an alkaloidal content ranging from 0.2 to 1.0 per cent., of which 0.025 to 0.056 is ephedrine and the remainder is pseudo-ephedrine.

E. gerardiana and *E. intermedia* are sometimes confused with *E. equisetina* which is a non-flowering plant, but the latter is never woody, its stems are hollow and the leaves are more numerous, and at the apex embrace the internodes not to the area from which they arise. The berries, roots, woody stocks and branches were found to contain very little ephedrine. The green stems are the only parts which give the highest amount of the alkaloids. The collection of the drug in the autumn before the winter frost sets in, is essential to get a good yield of alkaloid.

E. foliata Boiss. vern. *Kuchar*, grows in Baluchistan, Sind, Kurram valley, the Punjab plains, mainly in the southern portions, and the Salt Range up to 3,000 ft. It contains no alkaloid. Till recently, there has been a confusion about the correct nomenclature of Ephedra species growing in India. The important species of the medicinal herb growing in India along with their distribution is given as under. In the subsequent discussion the old classification is retained.

E. gerardiana Wall. syn. *E. vulgaris* Hook. f., non A. Rich. VERN.—Punjab.—*Asmania*, *Budagur*, *Cherwa*, *Butshubr*; Ladakh.—*Tse*, *Teapat*, *Trano*; Bushahr.—*Rachi*, *Khanda phag*. This species is found scattered in the drier regions of temperate and alpine Himalayas from Kashmir to Sikkim at altitudes of 7,000 to 16,000 ft. and is frequently met with at Pangri (Chamba), Lahul and Spiti (Kulu), Chini and Kilba Kailash ranges of Kanawar (Bashahr), Shali hills (north of Simla), Kashmir and Ladakh. In Lahul valley, it occurs along the catchments of the rivers Bhaga (Ghar valley), Chandra (Koksar valley) and Chandra Bhaga (Pattan valley). The plants found at Dattamula in Kashmir are rich in alkaloids. Var. *saxatilis* Stapf. is taller and ascending; it occurs in Garhwal and Kumaon. Var. *sikkimensis* Stapf. is erect, robust but soft; it occurs in Sikkim. The rhizomes have large knobs of the size of a football and are used as fuel by the Tibetans.

E. intermedia Schrenk & Mey. This is densely branched, erect or prostrate shrub, commonly met with in Pangri, Kanawar and to a lesser extent, in Kashmir, Kulu and Jaunsar. Four varieties of this species have been recorded, of which var. *tibetica* occurs in India. *E. pachyclada* Boiss. is a closely allied species found in Chitral, Baluchistan and Afghanistan.

E. major Host. syn. *E. nebrodensis* Tineo. This is an upright, rarely ascending, densely branched shrub, up to 6 ft. high, of which var. *procera* (Fisch. & Mey.) Aschers. & Graebn. is reported from Lahul. The twigs of this species closely resemble those of *E. gerardiana*.

E. foliata Boiss. & Kotschy is a tall scandent shrub, bearing edible fruits, found in the plains of southern Punjab and Rajasthan. Of the four recorded varieties of this species, var. *ciliata* (Mey.) Stapf. occurs in India. It does not contain any appreciable quantity of alkaloid.

CULTIVATION.—Medical species of ephedra have been successfully cultivated in U.S.A., England, Kenya and Australia. They can be grown in northern India at altitudes of 8,000 ft. or more in regions where the annual rainfall does not exceed 20 in. Parts of Jammu and Kashmir and Kulu valley are suitable for the cultivation of *E. gerardiana* and *E. major*. The plants are propagated by seeds, layers or divisions of the rootstock. Seeds are sown during early spring, 2 in. apart and 0.5 in. deep, in drills, the distance between rows being 30 in. Watering and weeding are necessary for about a year. The plants are hardy and grow satisfactorily even in extreme xerophytic conditions. Among the Indian species, *E. major* is the richest source of ephedrine. The plants collected from Lahul contain over 2.5 per cent. total alkaloids of which nearly three-fourths is ephedrine.

The total alkaloid content of the green stems of *E. intermedia* ranges from 0.7 to 2.33 per cent. of which only about one-tenth is ephedrine, the rest being pseudo-ephedrine. Ephedra of the B.F.C. consists of the dried young branches of *E. sinica* Stapf. and *E. equisetina* Bunge indigenous to China, and of *E. gerardiana* (including *E. major*) indigenous to India. It contains not less than 1.25 per cent. total alkaloids calculated as ephedrine. Ephedra of the I.P.L. consists of the dried narrow, green cylindrical twigs of *E. gerardiana* and *E. major*, collected in autumn, and containing not less than 1 per cent. total alkaloids calculated as ephedrine. It has a heavy, pine-like aromatic odour and a strong astringent taste. Ephedra in powder (*Pulvis Ephedrae*) complies with the standard for the unground drug.

CHEMISTRY OF EPHEDRINE AND PSEUDO-EPHEDRINE.—Ephedrine, $C_{10}H_{15}ON$, is a colourless crystalline substance, m.p. $41-42^{\circ}C$. The hydrochloride forms colourless needles, m.p. $216^{\circ}C$; specific rotation in water is -34.2° and in absolute alcohol -6.81° . The platinichloride of the base crystallizes in colourless needles, m.p. $186^{\circ}C$.

Pseudo-ephedrine or *iso-ephedrine*, $C_{10}H_{15}ON$, occurs with ephedrine in *E. gerardiana* and *E. intermedia* and is formed by heating ephedrine with hydrochloric acid. It is a dextro-rotatory isomer of ephedrine with a specific rotation of $+50^{\circ}$ in absolute alcohol and crystallises from ether, m.p. $118^{\circ}C$.

The base is a white, colourless, crystalline substance occurring in the form of long needles freely soluble in alcohol. The hydrochloride forms colourless needles, m.p. $179^{\circ}C$. It forms a remarkably soluble oxalate in contrast to the sparingly soluble ephedrine oxalate. The oxalate of ephedrine crystallises from water in fine needles sparingly soluble in water and less so in alcohol. This relative insolubility of ephedrine oxalate provides a fairly simple means of separating the alkaloid from the associated isomer d-pseudo-ephedrine.

The ratio of ephedrine to d-pseudo-ephedrine seems to vary with the different species, the real value of the herb being determined by a high γ -ephedrine content. The alkaloid ephedrine can exist in no less than six forms: γ -ephedrine, d-ephedrine, dy-ephedrine, γ -pseudo-ephedrine, d-pseudo-ephedrine and dy-pseudo-ephedrine.

After the separation of the alkaloids, γ -ephedrine and d-pseudo-ephedrine, there remains a small precipitate of oily residue which is still high in alkaloid content. From this oily residue Sydney Smith has separated two additional alkaloids γ -methyl ephedrine and nor-d-pseudo-ephedrine. γ -methyl ephedrine was prepared by distilling the oily residual alkaloids under reduced pressure and purified through the alcohol soluble oxalate, γ -methyl ephedrine has an optical rotation $[\alpha]_D = -29.2^{\circ}$

The alkaloids γ -ephedrine and d-pseudo-ephedrine are not particularly sensitive to potassic mercuric iodide solution. On the addition of that reagent to a 1 per cent. neutral solution of the sulphates of the alkaloid no precipitate occurs. Both alkaloids are precipitated in a 3 per cent. neutral solution but the precipitate is readily soluble in dilute acids. To the same reagent γ -methyl ephedrine and dy-pseudo-ephedrine behave in marked contrast to the above. They are readily precipitated from a 1 per cent. neutral solution of the sulphates, the precipitate remaining undissolved on the addition of dilute acid.

Probably the most important property of ephedrine is its stability; its solutions are not decomposed by light, air or heat, and age apparently does not affect their activity. Thus a solution of ephedrine hydrochloride, prepared and sealed in a sterile ampoule for 6 years, showed no change in appearance and produced the customary pressor response when injected into a pithed cat. Kendall and Witzmann (1907) have demonstrated the great resistance of ephedrine to oxidation as compared with epinephrine; the former is not oxidised by dibromophenolindophenol, methylene blue or indigo carmine, whilst the latter is oxidised by all these reagents. Pseudo-ephedrine hydrochloride is also very stable; a 1 per cent. solution still retains its properties after keeping at room temperature for many weeks and it is

believed may keep indefinitely without deterioration. Its solutions can be boiled without decomposition. Mixing with sera does not interfere with the activity of either ephedrine or pseudo-ephedrine, even after incubation for many hours.

EXPORT OF EPHEDRA.—The different species are so closely allied in their botanical characters that only a chemical analysis can show their value as a commercial article. There is every possibility of adulteration of the best specimens with the lowest grade without fear of detection. Ephedrine is a drug of great therapeutic value. If some sort of control is not exercised over the collection as well as the careful selection of the drug, Indian ephedra will have little chance of competing with the drug obtained from Chinese or other sources in the foreign market. Work carried out by Chopra and his co-workers and Krishna and Ghosh in this country has undoubtedly established the commercial values of *E. gerardiana* and *E. nebrodensis* and has shown that the Indian species are quite as rich in ephedrine content, if not in some cases richer, as the Chinese species. Already a demand for Indian ephedras has been created in India and elsewhere. It is difficult to get exact statistics of the exportation of any particular drug material because drugs are generally classed together in the customs returns. At a conservative estimate it may be said that about 2,000 mds. of ephedra were exported from India during 1928-29. These figures represent only a portion of the trade which has recently been developed in China. The figure for export from the whole of China is about 8,000 mds. a year. The principal source of supply of ephedra in India, before partition, was Baluchistan. Efforts are now being directed to tap sources within the country. Ephedra from Lahul, Pangi and Kashmir is suitable for commercial exploitation. Recent studies have shown that the drug from Sikkim is rich in alkaloids. One representative sample was found to contain 1.607 per cent. ephedrine hydrochloride.

Foreign markets demand ephedra containing more than 1 per cent. ephedrine and few consignments from India satisfy this requirement. Different species of Ephedra often occur together and it is difficult for collectors to distinguish one species from another. The possibility of adulteration of the best specimens with poor grades is ever present. This can be overcome by employing trained workers who can distinguish the species and collect the drug from suitable localities at the proper time. To obviate the difficulty due to the variation in the alkaloid content of commercial consignments, the Forest Research Institute, Dehra Dun, has recommended the manufacture and marketing of Ephedra Extract standardised to contain 18-20 per cent. of total alkaloids, and representing about 5 per cent. of the weight of the crude drug. The loss of alkaloids during extraction does not exceed 7-8 per cent. The extraction does not involve the use of any complicated equipment and it can be carried out with advantage in localities where the plants occur, thereby minimising the costs of handling and transport. The dry extract can be used for the preparation of pure ephedrine. According to the Report of the Panel for Fine Chemicals, Drug and Pharmaceuticals, 1946 the production of ephedrine in India was 3,000 lb. in 1945. The supply of ephedra came mainly from Baluchistan. Since partition, however, supplies from Baluchistan have become uncertain and ephedrine production in India has fallen.

The places where ephedra grows in India are accessible and the cost of the drug at road-heads is reported to be about Rs. 15 per md., which is comparable to the price at which supplies were being received from Baluchistan in the pre-partition years. It is possible to undertake commercial cultivation of selected species of Ephedra for ensuring regular supplies for the manufacture of ephedrine in India.

DISTRIBUTION OF INDIAN EPHEDRAS.—The following Table VI. shows the distribution of various species of ephedra growing in India:—

TABLE VI
INDIAN EPHEDRAS

Species	Locality	Authority	Remarks
<i>Ephedra foliata</i> Boiss.	Bombay and Plains of Sind, Salt Range up to 3,000 ft., Punjab, Rajputana, often gregarious, etc., on the barren desert.	Forest flora of Bombay Presidency and Sind by Talbot, Vol. II, p. 541	
<i>E. peduncularis</i> Boiss. (<i>E. foliata</i>)	Punjab, Rajputana and Sind	Flora of British India by Hooker, J., Vol. V, pp. 640 and 863	
<i>E. intermedia</i> Schrenk and Meyer	Kashmir	Flora of British India by Hooker, J., p. 863	
<i>E. vulgaris</i> Rich.	N. W. Dry stony hills of Afghanistan, Baluchistan, inner arid and intermediate Himalayas, Jhelum, Chenab and Sutlej 7,800 to 12,800 ft., West Tibet to 16,000 ft.; inner Kumaon and inner Sikkim and adjoining parts of Tibet	Forest flora of N. W. and Central India by Brandis	Syn. <i>E. gerardiana</i> Wall.
<i>E. gerardiana</i> Wall.	Kumaon. Occurs along the main Himalayan range between 6,500 to 14,000 ft. Very common on the inner dry ranges border- ing Tibet where it grows on open ex- posed shingly slopes or among rocks	A Flora of Kumaon by Osmaston	Syn. <i>E. vulgaris</i> Hook. f., non A. Rich.

Species	Locality	Authority	Remarks
<i>E. gerardiana</i> Wall.	North Garhwal Divn., C. Almora, E. Almora. Very common	Descriptive list of Trees and Shrubs between the Ganges and the Sarda Rivers by Osmaston	
Do.	Alpine Himalayas and Western Tibet and Sikkim	Flora of British India by Hooker, J., Vol. V, pp. 640 and 863	
	Temperate and Alpine Himalayas and Western Tibet in the drier regions 7,000 to 12,000 ft.; 12,000 to 16,000 ft. in Sikkim		
<i>E. gerardiana</i> var. <i>Wallichii</i>	Western Tibet, Kuna- war, Garhwal and Kumaon	Flora of British India by Hooker, Vol. V, pp. 640 and 863	
var. <i>β-saxatilis</i>	Garhwal and Kumaon	Do.	
var. <i>γ-sikkimensis</i>	Sikkim	Do.	
<i>E. nebrodensis</i> Tineo.	Lahoul and Western Tibet	Do.	Usually classed with <i>E. gerardiana</i> Wall.
var. <i>procera</i>			
<i>E. pachyclada</i> Boiss.	Garhwal. From Garh- wal westward ascending to 15,000 ft.	Do.	Syn. <i>E. intermedia</i> Shrenk & Mey.
var. <i>glauca</i>	Mongolia to Kashmir	Do.	
var. <i>tibetica</i>	Afghanistan border, Western Tibet, Afghanistan	Do.	
	Behar and Orissa	Botany of Behar and Orissa by Baines	Ephedras not found
	Northern Berar Forests	Descriptive Botanical list	Do.
	Northern Berar Forests	Descriptive Botanical List, Northern and Berar Forest Circles, C. P., by Witt	Do.
	Central Provinces	Descriptive List of Trees, Shrubs and Economic Herbs of the S. C. C. P., by Haines	Do.
	Chota Nagpur	A Forest Flora of Chota Nagpur, by Haines	Do.

Species	Locality	Authority	Remarks
<i>E. pachyclada</i> var. <i>tibetica</i>	Gangetic Plains	Flora of the Upper Gangetic Plain, Pts. I, II and III, by Duthie	Ephedras not found
	Chittagong and Hill Tracts	List of Plants of the Chittagong and Hill Tracts, by Heinig	Do.
	Darjeeling Dist.	Trees, Shrubs and large Climbers found in the Darjeeling District by Gamble	Do.
	Bengal	Bengal Plants by Prain	Do.
	Upper Assam and Khashi Hills	Preliminary List of Plants of Upper Assam including Khashi Hills by U. N. Kanjilal	Do.
	Nilgiri and Pulney Hill tops	The Flora of the Nilgiri and Pulney Hill tops by Pyson	Do.

VARIATION OF THE ALKALOID DUE TO SPECIES.—Read and Liu (1928) have pointed out that, the distribution of ephedra in the world is fairly wide. Many species of this plant are known, but the active principle is found only in a few. The American species usually do not contain any ephedrine, the European plant yields an isomeric substance pseudo-ephedrine, the Chinese and the Indian species contain both ephedrine and pseudo-ephedrine; the amount of any one of the two alkaloids depends upon the species. A detailed study of the Indian ephedras has been made by the senior author in collaboration with Krishna and Ghosh of the Forest Research Institute, Dehra Dun and their results have been recorded in Tables VII and VIII. Table VII gives the total alkaloid and the ephedrine percentage of three common species collected from different localities at about the same time of the year. It is unfortunate that figures for all the samples are not available for the months of October and November, when the ephedrine content is highest. Most of the samples recorded in Table VIII were obtained from private collectors and for the sake of convenience the months from June to September were chosen. These months, however, do not give the ideal conditions for comparison, as the influence of rainfall on the alkaloid cannot be neglected, especially in localities (Chakrata) where the rainfall in these months is high. This point has been discussed more fully elsewhere.

TABLE VII

Species	Locality of Collection	Month of Collection	Total Alkaloids per cent.	Ephedrine per cent.
<i>Ephedra foliata</i>	....	....	0.03	nil
<i>E. intermedia</i>	Razmak (Waziristan) ...	Aug. 1928	0.17	0.11
	Datakhel Do.	Sep. 1928	0.12	0.09
	Shingarh (Baluchistan)	Sep. 1929	0.42	0.19
	Zarghat (Baluchistan) ...	Sep. 1929	0.90	0.48
	Pangi (Bashahr)	July 1929	1.62	0.07
	Spiti (Kangra)	June 1929	1.20	0.05
	Gilgit (Kashmir)	July 1929	0.67	....
	Niabat Astor (Kashmir) ...	July 1929	0.75	0.08
	Kargil (Kashmir)	July 1929	1.17	0.05
	Chini Range (Bashahr Div.)	May 1929	2.33	0.38
<i>E. gerardiana</i> and <i>E. nebrodensis</i>	Razmak (Waziristan) .	May 1929	1.97	1.43
<i>E. gerardiana</i> and <i>E. nebrodensis</i>	Shahidum (Baluchistan) ...	Aug. 1929	1.40	0.98
	Sari Do. ..	Aug. 1929	1.31	0.90
	Shingarh Do.	Aug. 1929	1.67	1.12
	Zarghat Do.	Sept. 1929	1.34	0.96
	Narang (Kagan) ..	Aug. 1929	1.93	1.30
	Dhattamulla (Kashmir) ..	Aug. 1929	1.22	0.68
	Phari (Tibet Frontier) .	Nov. 1928	0.29	0.10
	Chakrata	Nov. 1929	0.93	0.72
	Hazara	May 1928	0.74	0.48
	Baramulla (Kashmir) ..	Nov. 1929	1.28	0.80
	Lahoul	Oct. 1929	2.79	1.93
	Plas Kohistan (Trans-Frontier)	Sep. 1928	1.14	0.84
	Kagan valley	July 1928	1.83	1.23
	Kagan	Oct. 1929	2.15	1.52
<i>E. equisetina</i>	China .. ..	....	1.58	0.98
<i>E. sinica</i> +	China .. ..	....	1.28	0.63

TABLE VIII

Locality	Altitude in feet	Species	Month of Collection, 1929	Total Alkaloids per cent.	Ephedrine per cent.	Percentage of Ephedrine in Total Alkaloids
Spiti (Kangra)	8,000-9,000	<i>Ephedra intermedia</i>	June	1.20	0.05	4.1
Gilgit (Kashmir)	4,890	"	July	0.67	—	—
Niabat Astor (Kashmir)	7,836	"	"	0.75	0.08	10.6
Pangi (Bashahr Div.)	8,500	<i>E. inter- media</i>	July	1.62	0.07	4.3
Kargil (Kashmir)	8,733	"	"	1.17	0.05	4.2
Shingarh (Baluchistan)	9,000	"	Sept.	0.42	0.19	45.2
Zarghat (Baluchistan)	8,000	"	"	0.90	0.48	53.3
Razmak (Waziristan) ...	8,500	<i>E. nebro- densis</i>	July	1.70	1.05	61.7
Shahidum (Baluchistan)	8,200	"	Aug.	1.40	0.98	70.0
Sari Do.	9,000	"	"	1.31	0.90	68.7
Shingarh Do.	9,000	"	"	1.67	1.12	67.0
Zarghat Do.	8,000	"	Sept.	1.34	0.96	71.6
Kardung (Lahoul)	10,000	"	July	2.56	1.63	63.6
Narang (Kagan)	8,000	<i>E. gerar- diana</i>	Aug.	1.93	1.30	67.3
Dhattamulla (Kashmir)	4,700	"	"	1.22	0.68	55.7
Chakrata	6,885	"	"	0.28	0.14	50.0

From these, it is clear that the variation of the alkaloid in the three species is very marked. The difference is not so great, so far as the total alkaloid is concerned, but it is well marked in the proportion of ephedrine to the total alkaloids. In general, *E. nebrodensis* and *E. gerardiana* appear to contain about 60 to 70 per cent. of ephedrine in the total alkaloids and *E. intermedia* about 10 per cent. The only exception to this is the *E. intermedia* obtained from

Baluchistan, which contains a comparatively low percentage of the total alkaloids but a high proportion of ephedrine. *E. intermedia* contains, as a rule, a proportionately high percentage of pseudo-ephedrine. The proportion of ephedrine in total alkaloids, as recorded here, is slightly different from that obtained by Read and Feng for Indian ephedras, where *E. intermedia* is shown to contain 30 to 40 per cent. of the total alkaloids. This difference may be explained as due to different methods of estimating the amount of ephedrine. The percentage of ephedrine given here is based on the weight of ephedrine hydrochloride actually isolated from the crude plant and not on the probable percentage of the base indicated by the biuret reaction, developed by Read and Feng. For purposes of comparison, the quantities of alkaloids found in the Indian, Chinese, American and African ephedras are given in Table IX.

TABLE IX

Country	Species	Total Alkaloids per cent.	Ephedrine per cent.	Pseudo-ephedrine per cent.
Indian	<i>Ephedra foliata</i>	0.03	nil	nil
	<i>E. intermedia</i>	2.33	0.40	1.8
	<i>E. gerardiana</i>	2.15	1.52	—
	<i>E. nebrodensis</i>	2.79	1.93	—
Chinese	<i>E. sinica</i>	1.315	1.118	0.263
	<i>E. equisetina</i>	1.754	1.579	0.264
American	<i>E. nevadensis</i>	—	nil	nil
	<i>E. trifurca</i>	—	nil	nil
	<i>E. californica</i>	0.014	nil	nil
African	<i>E. alata</i>	—	—	1.0

EFFECT OF ALTITUDE.—In the case of Chinese ephedras, it has been shown that the ephedrine contents vary with the altitude of the locality where the ephedras grow. Recent investigations by the senior author in collaboration with Krishna and Ghosh, on ephedras collected from different localities in India, however, have brought out certain new facts which do not agree with the findings recorded in the case of Chinese ephedras. From a reference to Table VIII, it will be seen that samples of *E. nebrodensis* collected from two different localities (Sari and Shingarh in Baluchistan) situated at an altitude of about 9,000 ft.

above the sea level show widely different figures (0.90 to 1.12 per cent.) so far as their ephedrine content is concerned. Samples of *E. gerardiana* from Dhattamulla (Kashmir) show an ephedrine content of 0.68 per cent. whereas same variety of ephedra collected from a different locality (Chakrata) situated at a higher level (6,885 ft.) show a lower ephedrine content. The altitude, therefore, has no apparent connection with the ephedrine content of Indian ephedras.

EFFECT OF RAINFALL.—Another interesting feature of the Indian ephedras is that the rainfall of the locality where the ephedras grow bears a distinct relationship with the ephedrine content of the plant. The greater the annual rainfall the smaller is the alkaloidal content. Not only does the annual rainfall affect the average ephedrine content, but an occasional heavy shower lowers the ephedrine content considerably. Such cases have been observed in many places, for instance in Kagan in Hazara where the collection of the drug was made in September after a continuous heavy rainfall, and in consequence, it showed a very low ephedrine content. Similarly, in Chakrata the cumulative effect of heavy rainfall in July and August is marked by a lower percentage of ephedrine in the August and September collections. In places like Kagan and Lahoul, where the snowfall takes place early in November, the maximum ephedrine content is attained in October; on the other hand in places like Chakrata, Baramulla and Chini, the maximum is reached in November. The effect of rainfall on the ephedrine content of Indian ephedras is given in Table X.

TABLE X

Locality	Average Annual Rainfall Inches	Average Total Alkaloids per cent.	Average Ephedrine per cent.
Kagan	3—10	1.90	1.20
Razmak	20	1.46	0.90
Kashmir	32	1.15	0.65
Baramulla	45	0.90	0.52
Chakrata	75	0.63	0.45

SEASONAL VARIATIONS.—It has moreover been noticed that the amount of ephedrine found in the ephedras varies with the time of the year when the collection is made. To study the seasonal variation of the alkaloidal content in ephedras, monthly collections of the three species were obtained from different localities in India, and assayed. The collection was made first in the month of April, when the plant brings out new shoots, and was carried on through the months when it flowers, till its maturing period in October and November, after which it begins

to show signs of withering. Read (1928), from his experiments on Chinese ephedras, has concluded "that there is a progressive increase in the content of ephedrine in *E. sinica* and *E. equisetina*, so that from spring to autumn there is an increase of about 200 per cent. This strongly supports the old Chinese custom of collecting the drug in the autumn". From the results of assays done, by Chopra and Dutt (1930) on Kashmir ephedras and Chopra, Krishna and Ghosh (1931) on ephedras derived from various localities in India, it is evident that the variation of the alkaloids from April to November in the Indian ephedras is not so great, nor is the variation so uniform and regular with each month, as shown by Read. In all the specimens analysed, the ephedrine content decreases beginning with the month of May and steadily goes down during the rainy months till it reaches the lowest point in August, i.e., at the end of the rainy season. From this point onwards, the alkaloid increases till it reaches its maximum in the autumn months, i.e., October and November and then it falls again during the cold months. The fall in the alkaloidal content from May to August in Indian ephedras cannot be attributed to anything except the climatic conditions.

EFFECT OF STORAGE.—A point of industrial interest that has also been studied is the effect of storage on the ephedrine content of the drug. From the results of the analyses given in table XI it appears that if the drug is thoroughly air-dried and stored in a dry place to prevent bacterial growth, it can be kept for a sufficiently long period without any diminution in its ephedrine content.

TABLE XI
THE EFFECT OF STORAGE ON THE EPHEDRINE CONTENT OF EPHEDRAS

Description	Date of collection	Date of analysis	Total alkaloid per cent.	Ephedrine per cent.
<i>Ephedra intermedia</i> from Chini	Nov. 1928	March 1929	2.08	0.50
		Dec. 1929	1.99	0.48
<i>E. gerardiana</i> from Kashmir	June 1928	Aug. 1928	0.86	0.55
		June 1929	0.76	0.47
		Dec. 1929	0.83	0.50
Do.	Oct. 1928	Nov. 1928	0.93	0.63
		June 1929	1.01	0.67
		Dec. 1929	0.92	0.60

EPHEDRINE IN OTHER INDIAN PLANTS.—Chopra and De (1930) have shown the presence of a sympathomimetic alkaloid in *Sida cordifolia* whose pharmacological action closely resembled that of ephedrine and they thought that the alkaloid was undoubtedly ephedrine. Later, Ghosh and Dutt (1930) have shown that the sympathomimetic alkaloid referred to above showed all the chemical and physical characteristics of ephedrine. This plant is distributed throughout the tropical and subtropical India and Ceylon, growing wild along the roadside. The roots, leaves and seeds are all used in the Hindu medicine as a stomachic and as a cardiac tonic. The whole plant (including leaves, seeds, stems and roots) contains the alkaloid to the extent of 0.085 per cent. The seeds contain much larger quantities, i.e., 0.32 per cent. The interesting point about this work is the occurrence of ephedrine in two entirely different divisions of the vegetable kingdom; the ephedras belong to the divisions of Gymnosperms while *Sida cordifolia* belongs to Angiosperms.

Chopra and De have also found the presence of a sympathomimetic alkaloid resembling ephedrine in *Moringa pterygosperma* (vern. Sajina).

PHARMACOLOGICAL ACTION OF EPHEDRINE AND PSEUDO-EPHEDRINE FROM INDIAN EPHEDRA.—After its discovery in about 1887, ephedrine received a great deal of attention from the chemical point of view, but besides its mydriatic actions noticed by the Japanese investigator Nagai, no advance was made so far as its action is concerned. In 1924 Chen and Schmidt published their paper on the pharmacological action of ephedrine and demonstrated its close physiological as well as clinical relationship to adrenaline. The action of ephedrine and pseudo-ephedrine, obtained from the Indian varieties of ephedra, has been fully worked out by the author and his co-workers. The action of the ephedrine has been found to be the same as that obtained from the Chinese plant which has been studied in great detail by various workers. Very little attention has however been paid to pseudo-ephedrine and as this is the alkaloid which occurs abundantly in the Indian varieties of ephedra, it was carefully studied by the author and his co-workers.

It was shown that pseudo-ephedrine stimulates both the inhibitory and the accelerator mechanisms of the heart and has a stimulating influence on the myocardium. The rise of blood pressure is not so great as in the case of ephedrine and is only partly due to sympathetic stimulation as it is still produced when the sympathetics are paralysed with ergotoxin. The occurrence of the rise after the vaso-motor fibres are paralysed shows that the alkaloid stimulates the unstriated muscle fibres of the blood vessels, and that the cardiac muscle is markedly stimulated.

The rise of blood pressure is considerable in such animals as the cat with such doses as 2 mg. and persists for from 20 to 30 minutes. Repetition of injections does not evoke an equally great response, the height of the pressor effect being gradually diminished as the number of injections increases.

The pulmonary pressure shows a marked rise, the action resembling that of adrenaline. This is one of the most constant effects of the drug. The rise appears to be due to contraction of the branches of the pulmonary artery and this also relieves the turgescence of the mucous membrane. There is at the same time a well-marked dilatation of the bronchioles and both these factors help in relieving the paroxysms of asthma. If in experimental animals an asthma like condition is produced by giving an injection of pilocarpine, the marked spasm produced is relieved immediately by an intravenous injection of 2 mg. of pseudo-ephedrine showing that the drug has a powerful bronchodilator effect.

The sympathomimetic action of this alkaloid is also clearly shown by the fact that immediately after an injection of 2 mg. of pseudo-ephedrine, the movements of the gut are

inhibited and there is a well-marked relaxation of the intestines. Perfusion of an isolated piece of the ileum of the rabbit shows a similar effect. Movements of the uterus of the cat *in situ* as well as of the isolated uterus in a uterine bath show marked inhibition and may stop altogether. Injection of 2 mg. of pseudo-ephedrine produces a persistent rise of blood pressure accompanied by a marked contraction in the size of the spleen resembling that obtained by adrenaline.

The volume of other abdominal viscera such as the kidneys shows an increase after an injection of the drug. These effects are produced by a general rise of blood pressure all over the body by the vasoconstricting action of the drug which forces the blood into the splanchnic area. It is also to be noted that the increase in the volume of the kidney corresponds to the increase in the systemic blood pressure; when this falls to normal, the kidney volume also becomes normal.

The increase in the volume of the kidney suggested that the alkaloid might have a diuretic action; the urine flow was, therefore, measured by putting a cannula into the ureters, the drops of urine emerging being recorded on the drum by an electro-magnet. The rate of secretion is markedly increased and it was also noted that the acceleration of the urine flow lasted as long as the blood-pressure effect lasted. In excessive doses, ephedrine causes nervousness, insomnia, headache, vertigo, palpitation, sweating, nausea and vomiting, occasionally precordial pain and sometimes dermatitis.

DIFFERENCE IN THE ACTION OF EPHEDRINE AND PSEUDO-EPHEDRINE.—From the experimental data collected, it is evident that the action of pseudo-ephedrine closely resembles that of ephedrine. Both the alkaloids pass through the liver unchanged and produce their usual effects whether injected into one of the mesenteric veins or into a systemic vein. They are both rapidly absorbed from the gastro-intestinal tract and their inhibiting effect on the musculature of the gut is about equal. Both the alkaloids produce a contraction of the blood vessels and a well-marked rise of blood pressure. The vasopressor effect is much stronger in case of ephedrine which acts almost entirely on the vasomotor nerve endings, while pseudo-ephedrine has been shown to have some action on the musculature of the vessels as well. The rise of pressure is also less marked in the pulmonary and portal areas with pseudo-ephedrine. Its dilator action on the bronchioles as well as its contracting action on the mucous membrane of the nose does not essentially differ in its potency from that of ephedrine. The effect of the two alkaloids on the kidney is to produce a dilatation of the blood vessels and an increase of the kidney volume, but the initial momentary constriction produced by ephedrine is absent in case of pseudo-ephedrine; the diuretic effect is much more marked in the case of the latter alkaloid. The action of the two alkaloids on the voluntary and involuntary muscles appears to be about equal.

THERAPEUTIC USES OF INDIAN EPHEDRA.—It has been already remarked that the pseudo-ephedrine content of many of the Indian species of ephedra is high. The yield of ephedrine from various varieties in many cases does not exceed 50 per cent. of the total alkaloids and is often considerably less. The price of the alkaloid was about Rs. 600 per lb. in 1932-35 and even at that, sufficient quantities are not available. Some of the Indian varieties contain much larger quantities of pseudo-ephedrine than ephedrine. In view of these facts we tried to see how far it was possible to substitute pseudo-ephedrine for ephedrine in therapeutics.

EPHEDRINE AND PSEUDO-EPHEDRINE IN THE TREATMENT OF ASTHMA.—

From the time the sympathomimetic action of ephedrine was discovered this alkaloid has been very extensively used in the treatment of asthma. The relief afforded by it, though not quite so instantaneous as adrenaline, is quick and certain; besides it can be taken by the mouth and need not be given by injection. It has, therefore, been used indiscriminately in a large number of cases with sometimes untoward results. We have known patients who have been in the habit of taking half a grain of the alkaloid twice a day for many months. In asthma clinic at the Calcutta School of Tropical Medicine, experience with the use of this alkaloid in the treatment of this symptom complex has not been altogether satisfactory. It undoubtedly controls the paroxysms and relieves the symptoms in a quarter of an hour to half an hour, but it is likely to produce unpleasant side effects. In some patients acute pain in the cardiac region lasting for 10 to 20 minutes has been observed and a feeling of distress in the pericardium is not an uncommon symptom in a large number of patients using the drug, owing to hypertension produced by stimulation of the vasomotor nerve-endings. Some patients get palpitation, flushing of the skin and tingling and numbness of the extremities; tachycardia and fainting fits may be produced. Patients suffering from inflammatory conditions of the skin, frequently get exacerbation after its use and quiescent conditions may become acutely active. Those suffering from organic disease of the heart, especially of the myocardium, get decompensation, probably owing to the depressant action on the heart muscle by excessive dosage. Besides this, the stimulating action of the alkaloid on the sympathetic is liable to produce persistent constipation, which aggravates certain types of asthma. Loss of appetite frequently occurs and digestive disturbances are not infrequent accompaniments. This drug has not been sufficiently long in use for us to know all its untoward and toxic effects, but they undoubtedly do exist. Caution is, therefore, recommended in its use, especially for prolonged periods in the treatment of such a symptom complex. Often the relief afforded is of short duration and there is temptation of repeating the drug. Its routine use in controlling the paroxysms without investigating the cause is to be strongly deprecated.

We have already pointed out that the pressor action of pseudo-ephedrine is much less powerful than that of ephedrine but its bronchodilator action appears to be quite as marked. The contraction of the branches of the pulmonary artery relieves the turgescence of the mucous membrane and this with the well-marked dilatation of the bronchioles helps in relieving the paroxysm. We have tried pseudo-ephedrine in the treatment of this condition with excellent results. Within 15 minutes to half an hour of oral administration of $\frac{1}{2}$ gr. of the alkaloid, the feeling of tightness round the chest is relieved and the patient's breathing becomes normal. A similar dose taken when the premonitions of an attack are felt generally stops the paroxysm. The effect in fact is just as rapid as that of ephedrine. Although we have not tried it on a sufficiently large scale and for long enough periods, the results so far have been encouraging and the side effects produced are not so unpleasant. If use of this alkaloid is extended in the treatment of

asthma and other conditions in which ephedrine is being used, not only will the cost of treatment be reduced but it may be possible to avoid the unpleasant side effects of the latter drug.

ALCOHOLIC EXTRACT OR TINCTURE PREPARED FROM INDIAN EPHEDRA.—An extract prepared from *E. gerardiana* and *E. intermedia*, first introduced by the author, has now been in use for many years. It is prepared by exhausting the dried powdered twigs of the plant with 90 per cent. alcohol, sufficient water being then added to make the strength of alcohol about 45 per cent.; 5.0 c.c. of the extract should contain $\frac{1}{2}$ gr. of the total alkaloids. This extract can be used either by itself or in combination with asthma mixtures and is very effective in controlling asthmatic paroxysms. It is considerably cheaper than the purified alkaloids and brings the use of this drug within the means of poor people. A weaker tincture is also on the market now.

EPHEDRINE AND PSEUDO-EPHEDRINE AS CARDIAC STIMULANTS.—The stimulant action of these alkaloids on the blood pressure is well-known and for this reason they have been used as cardiac stimulants. We have already pointed out that while ephedrine, especially in large doses, has a depressant action on the myocardium, pseudo-ephedrine on the other hand has the opposite stimulant action on the heart muscle. Besides its action on the vaso-motor nerve endings the latter alkaloid also stimulates the muscle fibres of the arterioles. The senior author has, therefore, tried an extract of ephedra which contains both ephedrine and pseudo-ephedrine (more of the latter) as a cardiac stimulant with encouraging results. This produced a well-marked beneficial effect when administered to patients in whom the action of the heart was weak and compensation was failing. Observations on a number of patients showed that there was a definite rise of blood pressure amounting to 10 to 20 mm. of mercury, after $\frac{1}{2}$ to 1 dr. doses, 2 or 3 times a day. Marked diuresis was produced in those patients in whom the function of the kidneys was disturbed from inefficient circulation.

EPIDEMIC DROPSY.—As is well-known, the heart is seriously affected in this condition and gives rise to such subjective symptoms as dyspnoea, palpitation, præcordial pain and even cardiac asthma. The rate of heart beat is accelerated from the very beginning of the disease. The first sound at the apex becomes short and sharp and later it becomes muffled; often the first sound is reduplicated. Later, a systolic murmur may be present at the apex due to dilatation of the heart producing mitral incompetence and sometimes a hæmic murmur is also audible at the pulmonary base. A presystolic murmur may be heard. In such cases *digitalis* gives unsatisfactory results; in fact some of the patients actually become worse. A number of other cardiac stimulants proved ineffective. In cases of left heart failure, the tincture of ephedra proved very effective. The patient felt relieved and the symptoms disappeared.

OTHER CARDIAC CONDITIONS.—The tincture of ephedra is also an excellent cardiac stimulant in toxic conditions of the heart produced by such infections as pneumonia, diphtheria, etc.

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ERYTHROXYLUM COCA Lam. (Erythroxylaceæ)**COCA, COCAINE PLANT**

The alkaloid cocaine derived from this plant is a very valuable drug in medicine. The plant grows to a height of 6 to 8 ft., the leaves are of a lively green tint, thin, opaque, oval and slightly tapering at the extremities. It thrives, best in hot and damp localities, but the leaves most preferred for medicinal purposes are grown in drier climates. The original home of the plant is South America but it can be grown in West Indies, India, Ceylon, Java and elsewhere. The composition of the leaves is very inconstant and varies with different specimen of leaves. Cocaine, the most important alkaloid, occurs to the extent of about 0.15 to 0.8 per cent. in the leaves associated with many other alkaloidal substances, cinnamyl cocaine, α -truxilline, β -truxilline, benzoyl-ecgonine, tropacocaine, hygrine, cuscohygrine, etc. These substances may be collectively termed 'cocaines' and are all derivatives of ecgonine. The total alkaloidal content of leaves varies from 0.5 to 1.5 per cent. but higher percentages (1.0-2.5) have been recorded from Java leaves. The proportion of cocaine in the total alkaloids varies in different commercial varieties. Truxillo, Peruvian and Java leaves are richer in total alkaloids than Bolivian leaves, but the proportion of cocaine present is reported to be 50 per cent. of the total alkaloids, whereas it is 70-80 per cent. in Bolivian leaves. Coca leaves grown experimentally in India contain 0.4-0.8 per cent. alkaloids, chiefly cocaine. The bark and seeds of *E. coca* also contain cocaine. The alkaloid content of the dried leaves diminishes during storage. It is practically lost in about seven months and it is usual to extract the total alkaloids from the leaves and to use the crude product for the eventual extraction of cocaine. Most of the cocaine of commerce is obtained not directly from the leaves but from ecgonine which is obtained by the hydrolysis of the secondary alkaloids present in the leaves, ecgonine being then methylated and benzoylated to cocaine by recognised methods. For this reason the estimation of total ecgonine of coca leaves has a commercial significance. Besides the alkaloids, coca leaves contain 0.06-0.13 per cent. of an essential oil, the chief constituent of which is methyl salicylate. A colouring matter, coca citrin has also been isolated from the leaves.

After the discovery of its value as an anaesthetic, the demand for coca leaf in Europe rapidly increased and efforts were made to start plantations on a large scale. The alkaloid cocaine is largely used by the medical profession in India.

A glance at the table of imported drugs and medicines will show how the quantity of imported cocaine is gradually increasing. Considerable quantities of cocaine are imported into India, principally from U. K. and Germany. Imports from Germany ceased from 1940-41. India imported 8,236 oz. of cocaine in 1934-35. Imports decreased to 293 oz. in 1942-43, but went up again from the following year reaching a maximum of 13,097 oz. in 1946-47. Imports during 1947-48 were insignificant.

E. coca has, however, never been cultivated in this country on a large scale. Some years ago (1926) it was suggested in the English daily press in India that cocaine-bearing *E. coca* was growing wild all over the country, that the people were learning the habit of chewing the coca leaf, and that there might be secret factories for manufacture of cocaine. In support of this theory, it was argued that large quantities of the drug were seized on railways and the cocaine habit was spreading rapidly and no one had been able to trace the source from which the drug was obtained. The alleged cultivation of coca plant was also referred to at a meeting of the Advisory Committee of the League of Nations on traffic in opium and other dangerous drugs in 1925. Careful inquiries were then made by the Government of India and recently we have been able to fully corroborate the views then expressed by the authorities. Neither *E. coca* nor any other plant from which cocaine can be produced is cultivated in India, except that *E. coca* is sometimes grown as an ornamental plant in the gardens in Bombay and there are specimens at the Royal Botanical Gardens, Calcutta, and in the Botanical Gardens at Madras and Kallar (in the Madras Presidency). So *E. coca*, far from growing wild all over the country, is not known to grow wild anywhere in India. A few plants were found in some of the Nilgiri estates, which were in all probability the relics of the experiment made in 1885, but even these contained little or no cocaine. The manufacture of cocaine is a highly technical process and there is no ground whatever for the belief that cocaine is secretly manufactured in India and, as will be shown in subsequent pages, there is no mystery whatsoever about the source of the illicit cocaine seized in India. It is undoubtedly all manufactured in certain countries outside India.

Experimental cultivation was taken up in India in Madras, Mysore, Bombay, Bengal, Assam and Chota Nagpur, towards the end of the last century, but proved a commercial failure. It is now occasionally found as an ornamental plant in gardens. Coca and its alkaloids are covered by the Dangerous Drugs Act, 1930 and rules framed by the Government of India under the Act. Cultivation of coca for the production of cocaine is prohibited and the importation, manufacture and sale of coca alkaloids are regulated by license under official control. *E. coca* requires a humid atmosphere and an evenly distributed rainfall not below 75-80 in. per annum, an even temperature between 59° and 68°F. also appears to be necessary. It thrives best in well drained moist loams rich in humus. The plant grows well in suitable localities at the sea level, but only those grown on lower slopes of hills produce leaves rich in alkaloids. It can be propagated by cuttings, but for raising plantations, seedlings are raised in nurseries and transplanted, at

6 ft. apart, in the field when 8–10 in. high or 12–16 months old. The first crop of leaves is gathered 1–3 years after planting. Only the stiff ripe leaves, easily detached on being bent, are collected. The young leaves are reported to be rich in cinnamylcocaine and this is replaced in the old leaves by cocaine or truxilline. The leaves are picked 3–4 times in a year and dried quickly, if possible in a single day. A yield of 1,500–2,000 lb. of dried leaves per acre per annum is reported. Though coca plants live to 40–50 years or even longer, the yield of leaves diminishes after the first few years and plantings have to be renewed after about 20 years.

The literature relating to *Erythroxylum* spp. and varieties of *E. coca* yielding the commercial drug is somewhat confused. Some consider all the drug-yielding types as varieties of *E. coca*, while other recognise distinct species as sources of the drug in different regions. The well-known commercial types are: (1) Huanuco or Bolivian coca (from typical *E. coca* Lam.), (2) Truxillo coca (from *E. truxillense* Rusby) and (3) Peruvian coca (from *E. novogranatense* Hieron.). Truxillo and Peruvian cocas differ from the Huanuco type in the size, shape and texture of the leaves. The type cultivated in Java and in Asian countries is generally *E. novogranatense*. It is reported to be less sensitive to variations of temperature and more suited to hot moist tropics than true *E. coca*.

USE OF *E. COCA* FOR EUPHORIC PURPOSES.—The use of coca leaf for euphoric purposes, however, started many centuries ago in South America; the natives of Peru and Bolivia were known to indulge in the leaves of *E. coca* as early as the fifteenth century. They were in the habit of chewing leaves during the times of great physical strain such as long laborious marches in the hills, as by so doing they felt refreshed and invigorated. The leaf was generally taken mixed with lime or ash of some plant. The powdered leaves were kept in flask-shaped pumpkin shells and were taken off in small quantities with a needle, the end of which was moistened in the mouth. There were a number of other preparations also made from the leaf which were used by the populace. The planters and miners of the land encouraged its use because they could get greater amount of work out of the labourers under its influence.

Although the alkaloid cocaine was discovered in 1859–60, the importance of the plant from the medicinal point of view grew more from 1884 and the export of dry leaves from South America started from that time. In order to reduce the cost of transport, factories were started in Peru about 1890 which manufactured crude cocaine for export to other parts of the world. During the year 1890, 1730 kg. of the crude alkaloid were exported and this increased to 10,600 kg. in 1901. It was in this way that the alkaloid replaced the leaves and the knowledge of the effects produced by it spread to other parts of the world. Between 1890 and 1900 cocaine began to be fairly largely used in the United States for euphoric purposes and the habit was also getting known to Europe, India and China. It was thought at that time that the administration of cocaine cured the morphia habit and alcoholism and this gave a stimulus to its use by the medical profession in the treatment of these conditions. Unfortunately, instead of curing morphinism it produced among many patients morphino-cocainism.

The successful use of the drug for producing local anaesthesia began to be appreciated more and more by medical men, and this increased the demand for the alkaloid to such an extent that it was considered worth while to prepare it by synthetic methods. The preparation

of the alkaloid, however, is easier and cheaper from the leaf, and large plantations were started in Java and other places. The world thus became independent of South America, and the alkaloid became comparatively cheap in price. The leaf from Java goes to factories in Europe, America and Japan, and the South American product has been practically driven out of the market. In 1922, 1.7 million kilograms with a cocaine content of 1.2 to 1.5 per cent. were exported from that island.

COCAINE HABIT IN INDIA.—As early as the nineties of the last century it was realised that cocaine was being used in certain parts of the province of Bengal and Bihar for its euphoric effects. The earliest record of its use came from a small town named Bhagalpur. The story is related of a big land owner of that place who contracted the habit accidentally after its use to relieve dental pain. So extraordinary were the effects produced on him that not only did he become habituated to its daily use but passed on the habit to many others. It was stated at that time that cocaine was secretly sold to a considerable extent to school boys and students, merchants and men of good class in the community. The price of the alkaloid at that time was Rs. 3 per dr. or about one anna per gr., and it was usually sold to the public in packets of $\frac{1}{2}$ gr., each. The evil effects produced by the drug were not fully appreciated at that time by the profession and the laity, and therefore, no restrictions were imposed on the sale and use of this dangerous drug.

The habit, however, spread so quickly from Bhagalpur to Calcutta and other large towns and the ravages produced by it in the addicts became so evident in a short time that it soon came to the notice of the medical profession and the authorities. Steps were at once taken by the Excise Department to restrict its import and sale. In the meantime, the evil had unfortunately taken root and many large towns had become affected. The habit had spread along the two main routes even to northern India. It worked its way up through Benares, Lucknow, Rampur, Saharanpur and Ambala on the one side, and through Allahabad, Cawnpore, Agra, Muttra and Delhi on the other side. We are credibly informed that in Delhi the addiction existed on a fairly extensive scale in the year 1900. In this town it is reputed to have spread through the agency of a medical practitioner who prescribed it as a stimulant and as a tonic. In Saharanpur the habit was fairly common 20 to 25 years ago, and there a trained midwife is said to have been responsible for its introduction. Tracing its progress further north there is no doubt that the spread of the habit to the town of Amritsar in the Punjab was through shawl merchants, who were in constant communication with Calcutta. From Amritsar the addiction spread to Lahore. Peshawar was also involved early owing to large number of inhabitants of this town being constantly on visits to Calcutta in connection with the fruit trade. A very able Excise officer of the North-West Frontier Province assured the author that Peshawaris were in a great measure responsible for trafficking in cocaine carried on in India. Large quantities of Charas (resin of *Cannabis sativa* manufactured in Central Asia) were smuggled through the North-West Frontier Province and sold at a very cheap price along the frontier. These were carried by them to such big centres as Bombay and Calcutta and were sold at very large profits. The proceeds of this sale were employed to smuggle cocaine back from the sea-port towns to different parts of India, particularly large towns of northern India. During recent years the habitual use of cocaine appears to have declined on account of restrictions placed on its import and sale.

After the isolation of the alkaloid, the chief method of taking the drug in the western countries was by hypodermic injection, and owing to difficulties of administration the habit did not spread to any great extent at that time. Soon, however, the easy method was discovered of taking it in the form of snuff and by rubbing it on the gums. This was quickly followed by spread of the habit to large centres of Negro population in the United States. The most common method of taking cocaine in India is by putting it in 'pan' or betel leaf. That is

the reason why addiction to the drug is more prevalent amongst people who indulge in 'pan' chewing. As is well-known the betel leaf is taken by mixing it with small quantities of catechu and slaked lime, a little betel-nut or sometimes spices, such as cinnamon, cardamom, ginger, etc., are also added. The drug is either mixed with the spices and then wrapped in the betel leaf or some of the addicts place the alkaloid on the dorsum of the tongue and then chew a 'pan' immediately afterwards. Addicts who have been indulging in the drug for a long time generally put the cocaine on the tongue and merely take a little lime and catechu afterwards dispensing with the betel leaf. It is said that by doing this the action of the drug is enhanced and the effects produced are stronger. Rarely the drug has been taken in the form of a solution, obtained on a doctor's prescription, the addict sipping the solution at intervals following it each time with a betel leaf. The method of rubbing the drug into the gums or taking it as a snuff is up to the present time unknown in this country. A rare method which is sometimes used, particularly by the prostitutes, is that of injecting a solution of cocaine into the vagina by means of a douche can. This gives the individual a sense of local constriction and the general systemic effects appear almost immediately. The sexual act is said to be prolonged if the drug is administered in this way.

THE EXTENT OF COCAINE HABIT IN INDIA.—It is not possible to say with any degree of accuracy the present extent of cocaine habit in India. Tuke (1914) said that the habit of taking cocaine was by no means confined to the poor and uneducated classes. From the information we have gathered from our work in the field in various provinces of India, it transpires that only members of the medical profession at first knew about the euphoric properties of cocaine, and that it was from them that the lay people learnt about its effects. As in early days there were no restrictions regarding the possession and sale of the alkaloid, the habit quickly spread from one commercial city to another on account of the more rapid methods of transport which were coming into vogue owing to the extension of the railway system in the earlier part of this century. The stimulant effects produced by the drug were a great attraction to a type of individual, who was ignorant of its evil effects on the system. Moreover, the enormous financial gain which the dealers in this nefarious traffic obtained, soon induced them to employ agents to push on their trade and to advocate and popularize its use. It thus came about that, even when restrictions were imposed, the use of the drug was not curtailed but rather spread, so much so that cocaine was a well-known commodity to many of the inhabitants of large towns in India. It was popularly believed to be a sexual stimulant, and many started it for this purpose. The immediate effect is said to be a gentle excitement with sensations of high enjoyment, lessening the desire for food and enabling the consumer to undergo considerable fatigue. Prolonged use results in the formation of a habit leading to physical and mental deterioration and even death. The other attraction for its use is that it has a most extraordinary effect, temporary though it be, in rapidly overcoming mental as well as physical fatigue. As we have already stated, its use rapidly spread from Calcutta to large towns along the two main railway routes

through the Uttar Pradesh, into the Punjab and to the North-Western Frontier Province and even to the tribal territory on the North-West Frontier of India. The drug was also smuggled into Bombay and on that side its use spread to different large cities of the Bombay Presidency (e.g., Ahmedabad), Central India and the Central Provinces. We have been impressed by the fact that it was the large towns along the main railway lines from Calcutta and Bombay which were affected. Large cities along the branch lines remained free from this addiction or were only affected in exceptional cases. The only part of India where the habit seems not to be known to any extent was the Madras State.

The amount seized by the Calcutta Customs alone in 1932 was 7,200 oz. and experienced officers place the seizures between 2 to 5 per cent. of the quantity actually got through; this means that somewhere 2,00,000 to 2,50,000 oz. of cocaine were successfully smuggled into the country. It was calculated by competent authorities that consumers in India must have paid between Rs. 270 lakhs and Rs. 648 lakhs to the retailers for their doses during 1929. This is an enormous sum of money. One can also form some idea of the total number of persons habituated to the drug from the above. Taking an average dose as 2 to 3 gr. daily there must have been somewhere between a quarter and half a million individuals taking cocaine in India for its euphoric effects. This figure is very much on the low side as a large amount of cocaine smuggled is heavily adulterated by the dealers in this country. Contraband cocaine brought into India clandestinely from Japan, China and Far Eastern countries and seized by customs authorities, was being destroyed as unfit for medicinal use. In 1933 the Central Board of Revenue decided to utilise seized cocaine for the production of B. P. cocaine hydrochloride and to supply it to medical stores depots at concessional rates. This work is now being carried out at the Central Revenues Control Laboratory, New Delhi. The work has been seasonal being dependent on quantities of confiscated cocaine received. The largest quantity purified was in the year 1937-38 when from about 1,202 oz. of confiscated cocaine, about 860 oz. of B. P. cocaine hydrochloride was produced. Supplies of the confiscated product have been scarcer in recent years. The smuggling of cocaine into India has practically stopped now and with it the cocaine habit has dwindled down practically to nothing.

EFFECTS OF COCAINE HABIT.—The disorders and effects produced by the habitual use of coca leaves, which are chewed, and the alkaloid cocaine are not the same. The differences are similar to those of opium and morphine. In fresh coca leaves there is a fragrant resin and other alkaloids, e.g., dextrococaine, etc. It is remarkable that as opposed to morphine, animals are said not to become accustomed to cocaine though a case has been recorded of a monkey who became a cocaine eater through imitation. The action of cocaine on the brain is very powerful; a single injection may cause serious disturbances of the functions of the brain, e.g., mental disorders, illusions, melancholia which appear after one day and frequently last for weeks and months. The prolonged abuse brings about gradual development of graver symptoms. A cachectic state appears, with extreme emaciation, gradual change of demeanour, apathy, hallucination and a passionate

desire for the drug. Will-power diminishes and indecision, a lack of sense of duty, capricious temper, obstinacy, forgetfulness, diffuseness in writing and speech, physical and intellectual instability set in. Conscientiousness is replaced by negligence, truthful people become liars and criminals and lovers of society seek solitude. The destructive action on the cerebral functions becomes apparent. Mental weakness, irritability, erroneous conclusions, suspicion, bitterness towards his environment, a false interpretation of things, insomnia, hallucination, abnormal sensations under the skin commonly occur. The unfortunate being leads a miserable life where hours are measured by the imperative necessity for a new dose of the drug. He becomes a physical, mental and moral wreck.

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EUCALYPTUS GLOBULUS Labill. (Myrtaceæ)

BLUE GUM-TREE

VERN.—Tam.—*Karpura maram*.

There are more than 300 species of the genus *Eucalyptus*, most of which are valued for their timber. Only about 25 species yield the eucalyptus oils of commerce, chief amongst which are *E. globulus*, *E. dumosa*, *E. sideroxylon*, *E. leucoxylon*, *E. elaeophora*, etc. Australia may be said to be the home of *Eucalyptus* in as much as it forms about 75 per cent. of the vegetation of that continent. *Eucalyptus* oil is distilled from the fresh leaves and terminal branches of the trees. It is very important commercially. Large quantities of the oil are employed in scenting soaps and also in separating mineral sulphides from their ores. Experiments on the use of the oil as a motor fuel have been carried out. The oil is employed in medicine and pharmacy to a large extent and its antiseptic and disinfectant properties are well-known. The constituents of eucalyptus oil have been thoroughly worked out. They may be classified as follows:—

(1) Oxide	..	....	e.g. cineole (eucalyptol).
(2) Alcohols	.....	.....	„ geraniol, eudesmol, methyl alcohol, terpineol, etc.
(3) Aldehydes	.....	.....	„ butaldehyde, valeraldehyde, cryptal, citral, citronellal, etc.
(4) Ketone	.....	.....	„ piperitone.
(5) Phenols	.....	.....	„ tasmanol, australol.
(6) Esters	.....	.....	„ geranyl acetate, butyl butyrate, etc.
(7) Terpenes	.....	.....	„ phellandrene, limonene, etc.
(8) Sesquiterpene	.....	.....	„ aromadendrene.
(9) Benzene hydrocarbon	.....	.....	„ cymene.
(10) Solid hydrocarbon	.....	.....	„ paraffin.
(11) Free acids	.....	.....	„ acetic acid, formic acid.

Of these, cineole (eucalyptol) is the most important ingredient from the medical point of view. Australol and cryptol have also been found to be efficient antiseptics with a carbolic acid co-efficient of 13 and 12.5 respectively, but these are seldom used as such. The British Pharmacopoeia prescribes that medicinal samples of eucalyptus should contain not less than 55 per cent. of cineole while the U. S. Pharmacopoeia requires the cineole content to be 70 per cent.

Eucalyptus trees are not natives of India but many species are grown in different parts of the country, notably in the Nilgiris. The tree is very valuable on account of the products it yields. The essential oils, dyes, perfumes and kinos are all very useful and attempts have been made during the last seventy to eighty years to cultivate them in many parts of the globe, e.g., California, Spain, South Africa, Algeria, East Africa, Mauritius, Java and Malaya. These attempts have mostly met with success. It is, however, necessary to find by experiment which species are most suitable to the particular country. Much depends on this selection. In Malaya, *E. rostrata* and *E. citriodora* flourish whereas *E. globulus* is found to be unsuitable.

EXPERIMENTAL WORK IN INDIA.—Considerable experimental work has been carried out in the past on the cultivation of eucalyptus in different parts of India under varying climatic conditions, both in the plains and on the hills. The records of early trials are however scanty. Many failures have been recorded due to attempts to grow species of the cooler parts of Australia in the plains or on lower elevations of the hills of India where the climate was unsuited to them. There has been confusion also as a result of wrong naming of seeds, mistaken identification of species and incomplete records of data. However, the results of trials are of interest and provide useful guidance to the selection of species for further experiments. The results have been critically examined by Troup, Parker and others, and it has been possible to indicate species suitable for various elevations and species on which further trials may prove profitable.

(1) SPECIES SUCCESSFUL IN THE PLAINS, PARTICULARLY OF NORTH INDIA: *E. melanophloia*, *E. microtheca* and *E. patentinervis*.

(2) SPECIES SUCCESSFUL ON THE NILGIRIS AND/OR SIMLA HILLS: *E. bicolor*, *E. botryoides*, *E. cornuta*, *E. eugenioides*, *E. ficifolia*, *E. gummifera*, *E. corymbosa*, *E. gunnii*, *E. leucoxydon*, *E. longifolia*, *E. maideni*, *E. microcorys*, *E. obliqua*, *E. pilularis*, *E. polyanthemus*, *E. regnana*, *E. resinifera*, *E. sideroxydon*, *E. stuartiana*, *E. triantha* and *E. viminalis*.

(3) SPECIES SUCCESSFUL ON BOTH PLAINS AND HILLS: *E. camaldulensis*, *E. citriodora*, *E. crebra*, *E. hemiphloia*, *E. melliodora*, *E. multiflora*, *E. paniculata*, *E. punctata*, *E. rudis*, *E. saligna*, *E. siderophloia* and *E. umbellata*.

(4) SPECIES GROWN ON A SMALL SCALE OR ONLY FOR ORNAMENT: *F. calophylla*, *E. capitellata*, *E. cinerea*, *E. dealbata*, *E. deglupta*, *E. drepanophylla*, *E. elaeophora*, *E. eximia*, *E. foecunda*, *E. gomphocephala*, *E. linearis*, *E. macrorhyncha*, *E. miniata*, *E. ovata*, *E. pauciflora*, *E. ptychocarpa*, *E. pulverulenta*, *E. redunca*, *E. sieberiana*, and *E. torelliana*.

(5) FURTHER TRIALS HAVE BEEN SUGGESTED TO REVEAL THE SUITABILITY OF THE FOLLOWING SPECIES FOR CULTIVATION UNDER INDIAN CONDITIONS: IN PLAINS: *E. alba*, *E. baueriana*, *E. bosistoana*, *E. deani*, *E. patens*, *E. propinqua*, *E. terminalis*, and *E. trachyphloia*; ON HILLS: *E. cladocalyx*, *E. dives*, *E. exserta*, *E. muelleriana*, *E. piperita* and *E. planchoniana*.

(6) THE FOLLOWING SPECIES HAVE BEEN TRIED IN PLAINS OR ON HILLS AND ARE REPORTED TO HAVE SHOWN HARDLY ANY SUCCESS: *E. alpina*, *E. andrewsi*, *E. baileyana*, *E. cosmophylla*, *E. decipiens*, *E. diversicolor*, *E. erythrocorys*, *E. erythronema*, *E. gigantea*, *E. guilfoylei*, *E. haemastoma*, *E. lehmannii*, *E. lindleyana*, *E. macarthuri*, *E. macrandra*, *E. macrocarpa*, *E. marginata*, *E. occidentalis*, *E. oleosa*, *E. platypus*, *E. populifolia*, *E. salmonophloia*, *E. salubris*, *E. smithii*, *E. stellulata*, *E. umbra*, *E. urnigera*, and *E. virgata*.

CULTIVATION.—Vegetative reproduction by cuttings bearing juvenile foliage has given successful results with some species in Australia, South Africa and Russia. Attempts have been made to develop methods of rooting cuttings bearing mature leaves. The usual method adopted in India for raising eucalypts is transplanting of nursery-raised seedlings. Seeds are sown in February–March in beds composed of loam and decayed manure or in flat boxes 4–5 in. deep. Seedlings when 2–4 in. high are picked out to 2–3 in. apart. Protection from the sun for a few hours in the middle of the day is essential. Seedlings are liable to damping off from excessive moisture; irrigation should therefore, be controlled. Seedlings are transplanted, preferably individually, in baskets or bamboo tubes and when about 12 in. high, they are transplanted in prepared pits. The time necessary for seedlings to attain transplantable size varied with the species and the elevation, and it is usual to vary the nursery schedule suitably so that transplantation may be carried out in the rainy season. Severe pruning of plants at the time of planting has been tried in the plains of the Punjab, apparently with complete success in the case of *E. camaldulensis*. Pruning, however, does not appear to have been tried with many species. A spacing of 8 ft. × 8 ft. to 12 ft. × 12 ft. is adopted on good soils for species which develop vigorously and tend to form clean boles; closer spacing is allowed on poor soils for species which develop slowly and tend to branch low. Young plants need protection from frost for 1–2 years. The land between rows of plants is worked once a month to keep the ground clean of grass and weeds during the first few years and thinnings are necessary for the sixth to the tenth year.

Eucalypts, as a rule are intolerant of shade. They have usually a spreading root system and are wind-firm. Many species coppice well. Young trees and species with thin or deciduous bark are susceptible to fire damage, though older trees, particularly those of species with persistent bark, are but little affected; most species have good power of recovery from fire damage. Aromatic eucalypts are not readily browsed by cattle.

Distillation of the oil was started in this country about 30 years ago and it is estimated that about 24,000 lb. of oil are produced annually. The oil obtained

from the leaves growing in the Nilgiri plantations was studied by Puran Singh. It contains pinene, cineole, sesquiterpene and free alcohols in small amounts, but unlike the Australian oil neither eudesmol nor aldehydes; phellandrene is likewise absent. The constants of the oil have also been determined: Specific gravity, 0.9065 to 0.9155; Optical rotation, $+5^{\circ}$ to $+10^{\circ}$; Refractive index, 1.463 to 1.466; Saponification value, 8.9 to 20; Cineole, 60 per cent. The oil is practically insoluble in 70 per cent. but dissolves in less than 1 volume of 80 per cent. alcohol. The British Pharmacopoeia (1948) has adopted the following standard: specific gravity, 0.910 to 0.930; optical rotation, -5° to $+5^{\circ}$; solubility in 70 per cent. alcohol, 1 in 5; cineole, 70 per cent. by volume. Essential oils of eucalypts may be grouped under (1) pharmaceutical or medicinal oils, (2) industrial oils and (3) perfumery oils. Cineole is the principal constituent of medicinal oils. The oils are obtained principally from *E. sideroxylon*, *E. leucoxylon* and *E. elaeophora*, all of which have been grown in India. The low yielding *E. globulus* is no longer used as a source of medicinal oil in Australia, although in India it is the only species from which oil is distilled for commercial purposes. Phellanderene and piperitone are the principal constituents of industrial oils, formerly used for mineral flotation. Of the species exploited for such oils in Australia, *E. dives* (type), which has been tried in India, has assumed importance as a source of l-piperitone used in the manufacture of synthetic thymol and menthol. For perfumery purposes, oils rich in terpeniol, citronellal, geranyl acetate and eudesmol are employed. *E. citriodora*, which contains citronellal, is exploited in India on a limited scale for perfumery oil.

A comparison of the properties of the Indian oil with the B. P. standards will convince anyone that the Indian oil satisfies very closely the pharmacopoeial requirements and may be used without hesitation for medicinal purposes. In fact the quantity of oil which is produced from the Nilgiri plantations is sold to the Government Medical Stores, Madras, and the authorities have never had any reason to find fault with it. Unfortunately all the species of eucalyptus growing in India have not proved to be equally valuable as the *E. globulus* type described above. Two species of eucalyptus growing in Dehra Dun have been examined by Ghosh (1919). The yield of the oil from *E. tereticornis* (*E. umbellata*) was about 0.66 per cent. from the fresh leaves and was free from phellandrene. The amount of cineole was found to be very low, only 10.4 per cent. The oil from *E. crebra* on the other hand, proved to be absolutely free from either cineole or phellandrene. These oils could not be used for medicinal purposes owing to the subnormal quantity or absence of cineole. It is, therefore, important to cultivate the proper species, and if this is done there is every chance of the enterprise becoming a success. It does not, however, seem likely that the Indian eucalyptus products will be able to compete with those from the Australian eucalyptus in commerce. The soil and climatic conditions of Australia are especially suitable and the Australian Commonwealth has never been slow to appreciate the value of the product and to exploit their resources to the best advantage. The enormous quantity of oil exported from that country will bear testimony to this statement.

In spite of successful attempts to grow the tree in other countries, Australia still maintains her lead in the supply of this oil.

EXPORT OF EUCALYPTUS OIL FROM AUSTRALIA

1921-22	.....	.....	.....	35,039 gallons	£24,470
1922-23	.....	.....	.....	53,129 "	£34,602
1923-24	.....	.....	.....	79,557 "	£65,858
1927-28	.....	.....	.....	107,876 "	£90,929
1928-29	.....	.....	.....	114,094 "	£85,009

In the field of medicine, the Indian oil should have better prospects. Phellandrene, which is present in the Australian oil to a fairly large extent, is very irritant to the bronchial mucosa, especially if inhaled and has been considered to be powerfully depressant to the heart. The British Pharmacopoeia tests expressly exclude oils containing much of this principle. The butyric and valerianic aldehydes also are obnoxious constituents in the Australian oil. Both these constituents are absent from the Indian oil and therefore this should merit better consideration by physicians as this oil is less likely to produce coughing and other unpleasant side-effects. In Australia, eucalyptus oils for medicinal purposes are refined by fractional redistillation before marketing. Amongst others the species exploited in Australia for producing eucalyptus oils are, *E. citriodora*, *E. dives*, *E. elaeophora*, *E. leucosylon*, *E. macarthuri*, *E. siderosylon*, and *E. smithii*. These have been tried in India for ornamental and fuel purposes. No attention appears to have been given to the essential oil obtainable from them. It has been suggested that efforts should be made to cultivate these species on a commercial scale and utilise them as sources of oil and also to introduce into India other species whose value in the Australian eucalyptus oil industry has been established.

Eucalypts are among the World's important hard woods and the principal source of timber in Australia. But they are not exploited as source of timber in India. *E. globulus* which is grown on plantation scale in the Nilgiris is exploited mainly for fuel, the production of Eucalyptus oil having developed only as a subsidiary cottage industry. Eucalyptus species have been used for afforestation of water-logged areas and colonisation of river banks and bared hill sides; some are recommended for soil binding and as wind-breaks. Some species have the capacity to absorb excess water from marshy areas and their planting is sometimes recommended as an anti-malarial measure. Some species of eucalypts are valued for ornament and avenue planting. A number of them provide bee pasturage.

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EUGENIA CARYOPHYLLUS Thunb. (Myrtaceæ)**Syn. Syzygium aromaticum Merr. (L. M. Perry)****CLOVES**

VERN.—Sans. and Beng.—*Lavanga*; Hind.—*Long, Laung*; Bomb.—*Lavang*;
 Tam.—*Kirambu*.

E. caryophyllus is a native of the Molucca islands and is cultivated in Zanzibar, Pemba, the Amboyna islands, Penang, Madagascar and to a lesser degree in the Seychelles, Reunion, Mauritius and Ceylon. It has also been cultivated in southern India. The flower buds of this plant yield the cloves of commerce. These are picked when the fleshy receptacle, which is at first green, has acquired a crimson colour. At this period of its growth, the clove is richest in oil. In Zanzibar and Pemba collection is made twice yearly between August and December. The inflorescences are collected from movable platforms or the buds are detached by means of bamboos. The cloves are dried in the open air on mats and separated from their peduncles, the latter forming a separate article of commerce known as clove stalks. If left too long on the tree, the buds open and the petals fall, leaving 'blown cloves'; later the fruits known as 'mother cloves' are produced. Cloves are imported in bales covered with matting made from strips of coconut leaves.

The dried flower buds (the cloves of commerce) are aromatic, stimulant, and carminative; they are used in various forms of gastric irritability and dyspepsia. In the Hindu and Mohammedan medicine, cloves are used in various conditions either in the form of a powder or a decoction made from them. The oil distilled from the flower buds is commonly used nowadays in Western medicine. It imparts a delicate aroma to the preparations and helps to disguise the taste of many obnoxious preparations. It easily mixes with grease, soap and spirit and is extensively made use of in the manufacture of perfumery. Cloves contain about 14 to 21 per cent. of volatile oil, 10 to 13 per cent. of tannin and a crystalline substance called caryophyllin. The latter is white and odourless and is soluble in ether and boiling alcohol. Clove stalk also yield 5–6 per cent. of volatile oil. The oil of clove is prepared by steam distillation and contains 34 to 95 per cent. of phenols, sesquiterpenes and small quantity of esters, ketones and alcohols. Medicinal oil has a phenol content of about 82 to 90 per cent. The oils which have relatively low phenol content are mainly used in pharmacy while the strong oils are used in the manufacture of vanillin. The demand for cloves and clove oil has increased greatly within recent years in Java, Sumatra, Borneo, China, Japan and India for the purpose of aromatising cigarette tobacco. As a spice, it is perhaps used all over the world.

Ninety per cent. of the world's supply of cloves is obtained from the two islands, Zanzibar and Pemba, where it was introduced about the year 1818 and where it forms the chief industry. The area of clove cultivation in Zanzibar and Pemba during the year 1919 was estimated at 52,000 acres with nearly 50,00,000

trees. The cultivation has steadily increased since then. An idea of the extent of the clove crops may be gained from the figures for the 1925-26 harvest which amounted to between 6,500 to 7,000 tons in Pemba and between 3,500 to 4,500 tons in Zanzibar. In the first six months from January to June 1927, for which figures are available, 1,450 tons were exported from Zanzibar alone. Of this, India took 58 per cent., the United Kingdom 16 per cent. and the United States 10 per cent. This shows that India is one of the most important consumers of cloves from outside. In India cloves are cultivated in Tirunelveli and Nilgiri hills and also in Malabar, Mathurai and Coimbatore districts. About 200 acres are under the crop at present and the total production is about 2,00,000 lb. annually. Each tree yields about 8 to 20 lb. dry cloves or about 1,000 lb. per acre. According to the Director of Agriculture, Madras, if cloves are grown in 1,500 acres of land, India can attain self sufficiency for this spice to some extent.

CULTIVATION.—Cloves thrive well in well drained sandy loam and laterite soil with a rainfall of 65 to 75 in. per annum. Propagation is done both by seed and by grafting. Grafted plants have dwarfed stature and bushy growth which are useful characters. Harvesting can be complete and easy if trees are short. When seeds are sown in nursery beds, the seedlings, after sometime when they are 6 in. high are put in individual baskets. After 3-4 months these seedlings are planted in 3 ft. cubic pits spaced at 20 to 30 ft. During the hot season hand watering is necessary. After 2 to 3 years the plants become hardy and rarely require irrigation and bear fruit in 6 to 10 years. Economic life of the tree is reported to be 60 years. There are no well-defined varieties of plant but differences do exist in regard to habit of growth, bearing capacity, quality, colour and shape of cloves. It has been observed that in the early stages 3 oz. of ammonium sulphate per tree helps in accelerating growth and early maturity.

Though the prospects of the clove industry have been greatly affected by the appearance in the market of the clove oil substitutes, the opinion is held by many experts that even at present the production of cloves is still profitable to the owners.

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EUONYMUS TINGENS Wall. (Celastraceæ)

DOGWOOD; SPINDLEWOOD; PRICKWOOD

VERN.—Hind.—*Bārphali*, *Sikhi*, *Kungku*, *Pāpar*, *Kēsari*; Kumaon.—*Gwali*;
Nepal—*Nerwar*, *Kasuri*; Simla—*Chopra*, *Marmakoul*; Jaunsar.—
Bhambelis, *Roini*.

The genus *Euonymus* consists of about forty species, most of which are scattered over the tropical regions of Asia, the Malay Archipelago, Europe and America. This drug has been used in medicine for a very long time and is said

to be mentioned in Pliny's book. Its purgative properties are not very pronounced but it is supposed to stimulate the liver, and this leads to increased secretion of the bile. In combination with cascara, and iridin, etc., it is prescribed by practitioners in cases of torpid liver with flatulence and indigestion. The *Euonymus* that is available in the Indian markets is mostly the dried root bark of *E. atropurpureus* Jacq. imported from the U.S.A.

The bark of *E. atropurpureus* contains several bodies like euonymol, atropurol, euonosteryl, mono-euonosteryl which are responsible for its activity. Some investigators have reported the presence of a glycoside and an alkaloid. The stem bark is also used in medicine. Several species of *Euonymus* trees are found growing in abundance in India. *E. tingens* Wall., *E. crenulatus* Wall. and *E. dichotomus* Heyne are small evergreen trees found in the hilly regions of the Western Peninsula. *E. pendulus* Wall., *E. lacerus* Buch.-Ham., *E. grandiflorus* Wall., *E. hamiltonianus* Wall. and *E. glaber* Roxb. are found in the Himalayas and in Assam. *E. glaber* is reported to occur also in Bengal and Bihar. These do not appear to have been used as purgative in the Western or indigenous system of medicine in India till recently. *E. tingens* Wall. which is now used in medicine is a small evergreen tree upto 25 ft. high found in temperate Himalayas from Sutlej to Nepal at altitudes of 6,500–10,000 ft. The bark is dark and corky outside, but yellow within. It is considered useful for diseases of the eye. It is used in cases of chronic constipation and dyspepsia. It contains almost all the active principles present in the bark of *E. atropurpureus* and has been recognised in the Indian Pharmaceutical Codex as a substitute for *Euonymus*. For use as a drug, the dried bark should contain not more than 4 per cent. acid-insoluble ash, not more than 3 per cent. adhering wood, and not more than 2 per cent. foreign organic matter. The inner bark of the tree yields a dye which is reported to be used in Nepal for marking 'tika' on the forehead used by Hindu married women. The wood is moderately hard and heavy close and even-grained. It is considered suitable for carving.

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FERULA NARTHEX Boiss. (Umbelliferae)

ASAFOETIDA

VERN.—Sans.—*Hingu*; Hind. and Beng.—*Hingra*, *Hing*; Bomb.—*Hingra*; Tam.—*Káyam*, *Perungayam*; Tel.—*Inguva*; Pers.—*Angusa*; Afg.—*Angusa*, *Kurna*, *Khora*.

Asafoetida is an oleo-gum-resin obtained by incision from the living rhizome and root of *F. foetida* Regal, *F. narthex* Boiss., and other species of *Ferula*. *F. foetida* grows in Persia, Kandhar, and Afghanistan. and *F. narthex* grows abundantly in the villages of Kashmir in Baltistan, Astore and in western Tibet

and Afghanistan. These species attain a height of about 3 meters. The other recognised species yielding the oleo-gum-resin are *F. alliaceae* Boiss., *F. rubricaulis* Boiss. and *F. asafœtida* Linn. There are at least two types of asafœtida, one turning red and brownish on exposure to the air and the other kind remaining pale buff or white. The commercial supplies reach Europe and America via Persian gulf ports and Bombay.

According to Trease it appears doubtful if the substance known to the ancients as *Laser* was the Asafoetida of modern commerce. Asafoetida seems to have been introduced from the East by the Arabian Physicians. Collection of Asafoetida in Persia and Turkistan takes place in the late spring. The head of the plant is cut, when the exudation oozes out and is collected. The process is continued for a second and a third time, the plant being cut down lower on each occasion. The plants are cut with a saw. The best grade is obtained from the first cutting and the product of the third cutting comes next in quality, that from the second cutting being of poor quality. The drug is imported into India via the Khyber or Bolan passes or from the Persian gulf ports. Most of the drug now appears to come by the latter route from ports such as Bunder Abbas to Bombay. It usually arrives in tin-lined cases holding from 50 to 200 kg. *F. fœtida* has been extensively used in India and has been held in great esteem in the indigenous medicine from the earliest times. It is reputed as a carminative and antispasmodic and is extensively used in hysteria and nervous disorders of women and children. It is used as a flavouring agent and forms a constituent of many spice mixtures used all over India. It is also used as an expectorant in chronic bronchitis and as a means of removing the intestinal flatulence. Large quantities are used in veterinary practice. Certain sauces are said to contain small proportions of asafœtida. It is chiefly for this reason that large quantities of this aromatic gum are imported. It has been estimated that on an average about 6,000 cwt. valued at Rs. 2,16,300 are brought in annually by Afghan merchants and sold to the frontier towns, which distribute it all over the plains of India. Undoubtedly some is exported but this is an insignificant amount (about 1 per cent. of the total import) and the major portion of the imported drug remains in India. It is recognised in the Indian Pharmacopoeia and the asafœtida yields not less than 50 per cent. of alcohol (90 per cent.) soluble extractive.

F. narthex which grows abundantly in the inner dry valleys of Kashmir and gives a fairly good yield of this gum-resin forms a good substitute for the imported commodity. Asafoetida occurs in two principal forms: (1) Tears: These are rounded or flattened and about 5 to 30 mm. in diameter. They are greyish-white, dull yellow, or reddish-brown in colour, some specimens acquiring the latter colour with age while others remain greyish or yellowish. The fractured surface either remains yellowish and translucent or gradually changes from an opaque milky-white through pink and red to reddish-brown. (2) Mass: This consists of similar tears to those described above agglutinated into masses and usually mixed with fruits, fragments of root, earth and other impurities. Mass asafœtida is the commonest commercial form. Asafoetida is much more readily

powdered if it is first cooled. It has a strong, alliaceous odour and a bitter, acrid and alliaceous taste.

CONSTITUENTS.—Asafoetida consists of a volatile oil, resin, gum and impurities. The tears and lump both contain about the same amount of volatile oil which has a particularly evil smell and contains sulphur compounds. According to analysis by Baumann (1929) asafoetida has the following approximate composition: Volatile oil and resin 50.1 per cent., asaresinol ferulate 16.57 per cent., free ferulic acid 1.33 per cent., ether insoluble resin 1 per cent., gum and impurities 31 per cent.

All parts of the plant emit a strong asafoetida smell. It is reported that June is the time for collecting asafoetida from stem when the fruit is unripe but roots are tapped in July and August when the leaves have fallen. It appears that asafoetida is not collected regularly in Kashmir. Some Pathans from Afghanistan used to visit the areas where the plant grows wild and collect the gum resin chiefly by tapping the stems and also to a lesser extent by chopping and boiling the roots with water and then evaporating the free water from the extract. The boiling process is said not to give good results obviously so because the essential oil is driven off. One plant is estimated to yield a total (0.4 oz.) of asafoetida in a year.

References:—

(1) Dutt, 1928, *Commercial Drugs of India*; (2) Humphreys, 1912, *Drugs in Commerce*; (3) *Sea-borne Trade Statistics of British India*, 1928-29; (4) Trease, G. E., 1952, *Text Book of Pharmacognosy*, 451; (5) Baumann, M., 1929, *Abstract in Y. B. Pharm.*, 6, 621; (6) *Indian Pharmacopoeial List*, 1946; (7) Krishna, S. and Badhwar, R. L., 1953, *Jour. Sci. Industr. Res., Suppl.* 12A, 276; (8) Amin Chand, 1932, *Ind. For.*, 58, 277; (9) *Indian Pharmaceutical Codex*, 1953.

FENICULUM VULGARE Mill. (Umbelliferae)

THE FENNEL

VERN.—Sans.—*Madhurika*; Hind.—*Bari saunf, Sonp, Sont*; Beng.—*Pan-mouri, Mauri*; Bomb.—*Bari-sopha*; Tam.—*Sohikire, Shombu*; Tel.—*Sopu, Pedda-jila-kurra*.

The fennel is a biennial or perennial herb commonly cultivated throughout India mostly on homestead lands. It can, however, be grown as a cold weather crop at all altitudes up to 6,000 ft. It is also found growing wild in various localities. It flourishes in open sites in alluvial soil devoid of excess of moisture.

F. vulgare Mill. and *F. capillaceum* Gilib. are the most important species which are cultivated in India, Java, Japan, Persia, Egypt, Greece, Italy, Rumania, Russia, Germany, Poland, etc., for the sake of their fruits which are largely used as a spice in cooking and in the preparation of pickles, candies, and liqueurs. The fruits yield 2 to 6.5 per cent. of an essential oil. The cultivated fennels differ from each other and from the wild fennels by such minor characteristics that some botanists would prefer to regard all of them as races or at most subspecies and

varieties of *E. vulgare*. There are numerous 'varieties' and races of fennel cultivated all the world over. No wonder then that fennel from different countries varies a good deal with regard to the size of the fruit, odour, taste, and the content of essential oil. The numerous 'varieties' and races of these species are hardly recognizable botanically.

The fennel or 'saunf' has been used by man for flavouring from times immemorial. Fennel fruit was used by the ancient Romans. The succulent shoots were also used by them as a vegetable and are so employed in southern Italy even at the present time. The cultivation of the plant in central Europe was encouraged by Emperor Charlemagne. At the present day it is one of the commonest spices used for culinary purposes, including the flavouring of soup and sauces, and in the manufacture of pickles, candies, liqueurs, etc. It is official in the pharmacopoeias of all countries, because of the presence of a volatile oil which possesses stimulant, aromatic, and carminative properties. It is constituent of compound liquorice powder, and is used in this and similar powders to allay their tendency to gripe. Mixed with sodium bicarbonate and syrup, it is also given to infants as a remedy against flatulence. It is also used as a masticatory all over India.

It is used in Europe in the manufacture of cordials and enters into the composition of fennel-water which is employed medicinally, mostly as a vehicle for other drugs and as a flavouring agent. Fennel fruits are in great demand in the indigenous medicine in India. It is considered as a stimulant, carminative and aromatic. A hot infusion is not infrequently used to increase the lacteal secretion and to produce free sweating. It is doubtful how far the claims of the indigenous medicine could be substantiated, but the fruits have a great commercial importance. In France particularly, fennel is cultivated on a fairly large scale. This may be estimated from the fact that the Department of Gard in France cultivates 300 hectares producing annually about 300,000 kg. of oil. Large quantities of the fruits are employed in that country in the liqueur industry, as much as 2,000,000 kg. on an average having been imported annually into France via Marseilles.

CULTIVATION.—Saunf is grown in India as a cold-weather crop, the method of cultivation followed being that of an ordinary market-garden crop. In some States, such as Bombay, it is cultivated to a larger extent. The land is prepared by ploughing, harrowing, and rolling three times between June and October. The seeds are broadcast by hand into the beds, about 9 lb. per acre being sufficient. These seeds take about 20 days to germinate, and when the plants are about 3 in. high the beds are freely irrigated every fortnight until January. The crop is cut in a rather green condition and left on the ground for 5 days or so. The yield of the fruit is said to vary between 280 and 1,120 lb. per acre, 720 lb. being considered a good average. In France, fennel is grown in furrows 28 to 30 in. apart, and, when the plants have grown to a height of 3 to 4 in., they are thinned out so as to leave a space of 4 to 6 in. between them. The yield is about 1,300 lb. per acre.

India exports nearly 500,000 kg. of fruits per year, but with the potential resources existing in India a distinct advance could be made towards capturing the markets of France by supplies of fruit and oil from this country. In view of the fact that the Indian oil compares favourably with that obtained from other countries, there is every prospect of success. An examination of the properties of the different oils will make this clear.

	French Oil	Galician Oil	Russian Oil	Indian Oil
Specific gravity at 15°C.	0.976	0.966	0.967	0.968
Optical rotation in 100 mm. tube	+16.0°	+22°	+23°	+21°
Melting point after solidification	12.5°	4.0°	4.4°	8.2°
Percentage of fenchone	.....	19.3	18.2	6.7

FENNEL FRUIT OIL.—The yield of the essential oil varies a good deal according to the fruit distilled. Ordinarily it varies from 1.5 to 4 per cent., but yields as low as 0.53 per cent. and as high as 6.5 per cent. are also obtained. Three samples of Indian fennel purchased from the bazar and analysed by Rao, Sudborough and Watson gave a yield of 0.53 to 0.82 per cent. (on dry basis) of an essential oil having a sweet and anise-like odour. According to Umney, the yield of oil from Indian fennel is 0.7 to 1.2 per cent., and according to the Indian Pharmaceutical Codex (1952) it varies from 1.0 to 2.9 per cent. and about 8.8 to 15.8 per cent. of fixed oil. This yield is rather low in comparison to the other sources as will be seen from the figures stated below:

Variety	Percentage of Oil
French sweet	2.1
German (Saxon)	4.7
Indian	0.72
Russian	4.8
Galician	4.4
Japanese	2.7

In German, Russian, and Galician fennels the essential oil content is high and it contains about 60 per cent. of anethole and 18 to 22 per cent. of the ketone, fenchone, $C_{10}H_{16}O$. The oil of sweet or Roman fennel contains little or no fenchone, Japanese contains about 10 per cent. and Indian about 6.7 per cent. of fenchone. Oils containing little fenchone usually have a high anethole content. Anethole, $C_{10}H_{12}O$, is a phenolic ether, it readily separates from the oil on cooling, particularly if a crystal of anethole be added. Its presence in the 'bitter' oils of fennel gives them their distinctive taste. According to Rao, Sudborough and Watson the characteristics of the oil obtained by them from Indian fruits purchased from Bazaar and by a previous worker are: sp. gr. at 15°C. 0.9680 to 0.9767; opt. rot. at 25°C. +11.7° to +21°; n_D^{25} , 1.5355 to 1.5383; congealing point, +5.5° to +9.0°; and solubility 1 in 1 volume of 90 per cent. alcohol. These constants are within the limits of those of the commercial sweet fennel oil. The oil contains over 70 per cent. of anethole and 6 per cent. of fenchone.

The fennel oil is an aromatic carminative, and is employed in the treatment of colic in children. It is largely used in Europe in culinary preparations and in

the manufacture of cordials and liqueurs. It does not appear to be much used in perfumery, but is occasionally employed in scenting soaps. The fruit, after distillation of the essential oil, is a valuable cattle food as it contains 14 to 22 per cent. of proteins and 12 to 20 per cent. of fat.

From the point of view of commercial exploitation, the low yield might be prejudicial to the growers. Pure anethole has also been placed on the market so that the importance of the oil has to a great extent gone into the background. Further investigations should be carried out to determine whether by proper and scientific cultivation this yield can be increased or not.

References:—

(1) Finnmere, 1926, *The Essential Oils*; (2) Rao, Sudborough and Watson, 1925, *J. Ind. Inst. Sci.*, 184; (3) Umney, J. C., 1897, *Pharm. Jour.*, 4, 225; (4) Trease, G. E., 1952, *Text Book of Pharmacognosy*, 440; (5) Krishna, S. and Badhwar, R. L., 1953, *Jour. Sci. Industr. Res.*, 12A, 276, Suppl.; (6) *Indian Pharmaceutical Codex*, 1952, 107.

GAULTHERIA FRAGRANTISSIMA Wall. (Ericaceæ)

INDIAN WINTERGREEN

VERN.—Jav.—*Gandapuro*.

Oil of gaultheria (oil of wintergreen) is largely used in medicine as an external application for rheumatic affections, sciatica, neuralgia, etc. It is a very popular remedy and seldom will a prescription for aches and pains be met with where the physician does not use this drug. In almost all the proprietary balms, liniments or ointments, oil of wintergreen or its chief constituent methyl-salicylate occurs to a greater or lesser extent. Apart from its use in medicine, it is also used as a flavouring agent in tooth pastes, etc.

Oil of wintergreen is obtained by distilling the leaves and sometimes the whole herb of *G. procumbens*, a plant indigenous to the United States of America. A similar oil is distilled from the wood and bark of *Betula lenta* (the sweet birch) which grows profusely in the mountains of the Carolinas, Tennessee, Kentucky and Pennsylvania and this is now largely sold as wintergreen oil. The chief constituent of both these oils is methyl-salicylate, but the sweet birch oil differ slightly in composition from the true wintergreen oil. The composition of the two oils, according to Power and Kleber is as follows:

Oil of Gaultheria	Oil of Sweet Birch
Methyl-salicylate 99.0 per cent.	Methyl-salicylate 99.8 per cent.
Paraffin	Paraffin
An aldehyde or ketone	An aldehyde or ketone
Ester	Ester
A secondary alcohol	Optically inactive
Optically active	

The British Pharmacopoeia allows the use of both oils under the name of 'Oil of Gaultheria' while the United States Pharmacopoeia, recognising that these oils are composed chiefly of methyl-salicylate has made methyl-salicylate official. But all the three articles namely synthetic methyl-salicylate, oil of gaultheria and sweet birch oil are allowed by the authorities provided the label states which

source has been employed. Methyl-salicylate has further been discovered in many plants of the families, Betulaceæ, Rosaceæ, Polygalaceæ, Ericaceæ, Leguminosæ, etc., growing in different parts of the world, but the active principle in some of them is present in too small quantities to be of any commercial value.

G. fragrantissima Wall., grows freely in the Nilgiris, in Travancore, near Toungoo in Burma and particularly in Assam. It is found from Nepal to Bhutan at altitudes of 6,000 to 8,000 ft. and also on the Khasia hills and Western ghats. Puran Singh (1917) studied its distillation products with a view to its commercial exploitation. He found that only the Assam herb contains sufficient oil for commercial purposes. The results of his experiments were as follows:

		Fresh Herb	Dry Herb
(1) Nilgiris Gaultheria	350 lb.	0.036 per cent.	0.067 per cent.
(2) " "	500 "	0.120 " "	0.23 " "
(3) Assam "	350 "	0.65 " "	1.2 " "

The properties of the Indian wintergreen oil have also been found to be very similar to those obtained from other countries. The constants of the Assam oil are as follows: Specific gravity 1.185; optically inactive; soluble in 6 parts of 70 per cent. alcohol; methyl-salicylate content 99.1 per cent. Refractive index at 20°C., 1.537 to 1.539, colourless or nearly colourless, with a characteristic strong odour and sweet, aromatic pungent taste.

ECONOMIC ASPECTS.—It will be seen that methyl-salicylate constitutes from 95 to 99 per cent. of oil of wintergreen and oil of sweet birch. Oil of wintergreen was formerly used largely for the manufacture of 'natural' salicylic acid. The situation has changed considerably since the production of synthetic methyl-salicylate from coal tar. For some time the natural product was still preferred on account of the presence of certain objectionable impurities in the synthetic methyl-salicylate. The manufacture of the latter has now reached such a state of perfection that the natural product from wintergreen possesses no advantage. The price of the synthetic product is also much cheaper than the natural product. Furthermore, oil of gaultheria, according to the British Pharmaceutical Codex, may give rise to an eruption at the site of application much more frequently than the synthetic product. It is not surprising, therefore, that the synthetic product has largely supplanted the natural in general use.

Though the outlook of the commercial utilisation of the natural product from *G. fragrantissima* of India does not seem very bright, there is no reason why the existing resources should be allowed to go waste and why proper investigation should not be taken up. According to Puran Singh (1917) the yield of the oil from the Indian plant is rather low, but by improved methods of distillation the yield of the oil could probably be increased. Experiments carried out in Germany by Ziegelmann show that by macerating the material some time before distillation a better yield is obtained. This will be evident from the following statement:

Yield of Oil per cent. (Sweet Birch Bark)	Yield of Oil per cent. (Gaultheria Leaves)
0.20 (no maceration)	0.70
0.41 (maceration 12 hours at 40°C)	1.30

It is probable, therefore, that if improved methods of extraction are followed as in Germany, gaultheria oil production in India may be a profitable proposition with cultivation to ensure regular supplies, the oil could be produced in Assam at Rs. 1-10 as compared to Rs. 4 per lb. for the synthetic methyl-salicylate. Though the price of the synthetic product has come down considerably (Rs. 2-8 per lb.) still there is handsome margin of profit left for the producers. India can at least supply her own needs of oil of wintergreen from the resources existing in her own soil.

References:—

(1) Finnemore, 1926, *The Essential Oils*; (2) Schimmel & Co., 1895, *Report*; (3) Puran Singh, 1917, *Ind. For. Rec.*; (4) Chopra, R. N., and Badhwar, R. L., and Ghosh, S., 1949, *Poisonous Plants of India*, I, 605.

GENTIANA KURROO Royle (Gentianaceæ)

INDIAN GENTIAN ROOT

VERN.—Beng. and Hind.—*Karu, Kutki*; Bomb.—*Phashanvada*; Guj.—*Pakhan-bhed*; Punj.—*Nilkant, Kamalphul*.

PICRORHIZA KURROO Linn. (Scrophulariaceæ)

VERN.—Sans.—*Katuka, Katurohini*; Hind. and Beng.—*Katki, Kuru*; Punj.—*Kali kutki*; Bomb.—*Balkadu*; Tam.—*Katuku-rohani*; Arab. and Pers.—*Kharbage-hindi*; Kash.—*Kour*.

Gentian has been known as a medicine from antiquity, and many of the complex preparations handed down from the ancient Greek and Arabian physicians include it among their ingredients. It is one of the most important bitters in the Pharmacopoeia and is very extensively used. It possesses in a high degree the tonic properties which characterise all the simple bitters. On account of its aromatic properties it is agreeable to take and because of the absence of tannin it has no astringent action. It is, therefore, preferred to many other bitters and enters into most of the stomachic and tonic prescriptions of modern practice. The official source of the drug is the rhizome and roots of *G. lutea* (the common European yellow gentian)—a handsome perennial herb growing in the Alpine and Subalpine regions of central and southern Europe. The dried roots in cylindrical pieces, entire or longitudinally split, are imported extensively into India. Several species of Gentian, e.g., *G. kurroo*, *G. decumbens*, *G. tenella*, etc., are met with in the mountainous regions of India, but these are not utilised to any extent in medical practice, though all the varieties are to a greater or less extent characterised by the bitterness of their stems and roots. *G. kurroo* appears to be the best known and most widely employed species as a substitute for the official drug and is now recognised in the Indian Pharmaceutical Codex, 1952. This is a small herb with a handsome blue flower common in Kashmir and north-west Himalayas at an altitude of 5,000 to 11,000 ft. The plant grows in mountainous places and shows very poor adaptability in situation beyond its natural range. For its best

development under cultivation, partial shade is helpful. It takes some years for the plants to produce flowers and a considerable time elapses before the roots reach marketable size. It grows on bare hill sides as well as on the ledges of rocks. It is largely exported from the hills to the plains but on account of the fact that no detailed chemical study of the composition has been done so far, medical men and manufacturers of pharmaceutical products cannot make use of them. A sample of the roots of this species received from Kashmir, was analysed with the following results:

	<i>Gentiana kurroo</i>	<i>Gentiana lutea</i> (B. P. Standard)
Aqueous extract	20 per cent.	30—40 per cent.
Ash	0.70 per cent.	Not more than 6 per cent.
Gentiopicroin	Nil	1.5 per cent.

It will appear from the above, that this species of *Gentian* does not contain gentiopicroin, which is considered to be the active principle of *G. lutea*. From the scientific standpoint, therefore, the *G. kurroo* roots cannot be used as a substitute for the official drug. According to the British Pharmaceutical Codex, however, the process of drying of the gentian roots may have a marked effect on their ultimate composition. Gentiopicroin, the active principle, is present in fresh *G. lutea* roots and if these are allowed to undergo slow drying, Gentiopicroin is likely to be hydrolysed, to a greater or less extent, by fermentative changes with consequent diminution of water-soluble substances. It is, therefore, possible that the absence of gentiopicroin and the lack of aqueous extractives in the *G. kurroo* roots, is due to the process of drying adopted in Kashmir before the samples were sent to the Dehra Dun Institute for analysis. According to I. P. C. (1952) roots contain a bitter principle, 20 per cent. of yellow brittle, transparent resin resembling mastic. The resin is neutral and tasteless, insoluble in alkali solution. It does not contain the gentiopicroin the supposed active principle of *G. lutea*.

It will be useful, in this connection, to discuss *P. kurrooa* Linn., as this is very commonly used either as an adulterant or as a substitute for *G. kurroo*. Great confusion exists with regard to the identity of these drugs as the name *katki* is employed in the vernacular to mean both of them. *P. kurrooa* is considered in the indigenous medicine to be a valuable bitter tonic almost as efficacious as gentian. Further, it has the reputation of being an antiperiodic and cholagogue. The plant is found in north-west Himalayas from Kashmir to Sikkim. Specimens of the plant have been collected from Garhwal, Chamba, Hazara District, Kashmir, Gilgit, north-west Himalayas and Sikkim Himalayas. The plant is a more or less hairy herb, with perennial woody bitter rhizome about 15–25 cm. long, clothed with dry leaf bases. It appears to be fairly extensively used in those localities by the people and there is also evidence to show that a fairly large quantity is collected and sent down regularly to the plains. The main supply of the root is met from the north-west and Sikkim Himalayas. The plant may be cultivated at higher altitudes in the Himalayas between 9,000 to 15,000 ft. Propagation may be effected from the rhizomes but natural propagation is effected from the seeds. A systematic chemical investigation of the roots was undertaken with a view to

determine the active principles responsible for its action. On extraction with different solvents the following results were obtained:

Petroleum Ether Extract	....	....	1.49 per cent.
Sulphuric Ether Extract	..	..	3.45 " "
Absolute Alcoholic Extract	"	"	32.42 " "
Aqueous Extract	...	...	8.46 " "

On further examination of different extracts, it was found that—(a) Petroleum ether extract contains a trace of an alkaloid and a waxy substance melting at 39°C. (b) Sulphuric ether extract contains a glycoside, tannins and organic acids. (c) Alcoholic extract contains a glycoside, resins, etc. (d) Aqueous extract contains sugar, large quantities of bitter substance, etc.

The percentage of the bitter substance in the drug was found to be 26.6 per cent. A glycoside was obtained as a cream coloured amorphous powder, extremely bitter and hygroscopic having a specific rotation of -100° (in aqueous solution). It is freely soluble in water, acetone, alcohol and acetic ether; insoluble in chloroform, benzene, ether, etc.

From the above it will appear that *Picrorhiza* contains a fairly large percentage of bitter substance. As the pharmacological activity of gentian depends on the bitter principle contained in it, *P. kurroo* Linn. is used on a more extensive scale in cases where bitters are indicated. It is a recognised substitute in Indian Pharmaceutical Codex 1952.

References:—

(1) Dutt, 1928, *Commercial Drugs of India*; (2) *British Pharmaceutical Codex*, 1926; (3) *Indian Pharmaceutical Codex*, 1952; (4) Trease, G. F., 1952, *Text Book of Pharmacognosy*; (5) Dutta, S. C., and Mukerji, B., 1950, *Pharmacognosy of Indian Root and Rhizome Drugs*, 95, 108.

GLYCYRRHIZA GLABRA Linn. (Leguminosæ)

LIQUORICE

VERN.—Beng. and Bomb.—*Jashtimadhu*; Guj.—*Jethimadha*; Hind.—*Mulhatti*, *Jethimadh*; Punj.—*Muleti*; Sans.—*Madhuyashti*, *Yashtimadhu*; Tam.—*Adimaduram*; Tel.—*Atimaduramu*, *Yashtimadhukam*.

G. glabra or liquorice has been known in pharmacy for thousands of years. In old Chinese pharmacy, it was considered to belong to drugs of the first class and to it was ascribed the property of rejuvenating those who consume it for long periods. It was used to allay thirst, feverishness, pain, cough and distress of breathing. For many centuries China has used large quantities of liquorice, and many preparations of it are still sold in Chinese apothecary shops. Glycyrrhiza plays an important part in Hindu medicine and is one of the principal drugs of the 'Susruta'. In ancient Egypt, Greece and Rome glycyrrhiza was also frequently used. Liquorice is referred to by Theophrastus. The Roman writers referred to it as *Radix dulcis*, but it does not appear to have been cultivated in Italy until about the thirteenth century. Its cultivation in England has been traced back as far as the sixteenth century. Evidence shows that it was much used in Europe in the middle ages. It is interesting to find that even to this day liquorice is maintaining its place in medicine and pharmacy.

The dried roots of this plant are commonly sold by drug sellers in the Indian bazars. Indigenous liquorice is obtainable in Baluchistan and N. W. F. P. (Pakistan) but has not been reported to be growing in India. The main supply of the root is imported from the Persian Gulf, Asia Minor, Turkestan, Siberia, etc. It is also cultivated in China, France, Germany, Italy, etc.

THE PLANT YIELDING MOST OF THE COMMERCIAL DRUG.—*G. glabra* var. *typica* Reg. and Herd., a plant about 4 or 5 ft. high bears typical papilionaceous flowers of a purplish blue colour. The underground portion consists of long roots and thin rhizomes or stolons. The principal root divides just below the crown into several branches which penetrate the soil to a depth of 4 ft. or more. A considerable number of stolons are also given off, which attain a length of 5 or 6 ft. but run nearer to the surface than the roots. This plant is grown in Spain (Old Castile, Navarra, Aragon, Catalonia, Valencia, and Andalusia), Italy (Calabria and Sicily), England (Yorkshire), France, Germany, and the U. S. A.

G. glabra Linn. var. *glandulifera* Wald. and Kit. is abundant in the wild state in Galicia and central and southern Russia. The underground portion consist of a large rootstock, which bears numerous long roots but no stolons.

G. glabra var. *violacea* Boiss., yields the 'Persian' liquorice, which is collected in Iran and Iraq in the valleys of the Tigris and Euphrates. As its name implies, it bears violet flowers.

PRODUCTION AND COMMERCE.—The plant grows wild and is cultivated in Southern Europe, Syria, Iraq, Turkey, Greece and Russia; these are the chief sources of export. The Commercial supplies of the root come from Barcelona, Alicante, Seville, Spain, Iraq, Russia, Leghorn, Italy, Smyrna, Alexandretta, Haifa, Syria, Greece, Egypt, Balgium, France and Germany. The root is usually named after the country in which it was grown. The plant is found growing in the N. W. Provinces in Pakistan in a wild state and large quantities of these roots are annually imported into India. There is a good trade in this root and U. S. A. alone consumed in 1939 an average of 62,330,968 lb. of liquorice root and 466,269 lb. of liquorice extract. In 1940, U. S. A. imported 56,247,857 lb. of root. Spain is the largest producer of cultivated liquorice. Chinese liquorice root is of very good quality and is obtained from *G. malensis*.

USES.—It is considered a demulcent, expectorant and flavouring agent. The powdered liquorice root is used for various pharmaceutical purposes as in the preparation of pills, either to give due consistence or to cover their surface and prevent them from cohering and as a diluent of powdered extracts, etc. As a remedial agent it has almost entirely been replaced by the extract. The preparations of liquorice are very popular in Western medicine as a mild laxative. They are also largely used as constituents of cough syrups, throat lozenges and pastilles. The chief role which liquorice is playing in pharmacy is in covering the acrid taste of many nauseous drugs, particularly senna, aloes, chloride of aluminium, senega,

hyoscyamus, turpentine, etc. For relieving pain, discomfort and other symptoms caused by acrid matter in the stomach, it is wonderful. It seems to remove the irritating effects of acids in a better way than alkalies. It is used by the practitioners of the indigenous systems as a tonic, as a demulcent in catarrh of the genito-urinary passages and as a mild laxative. The importation of this drug is of some consequence from the economic point of view, as it is not only used in medicine, but has also been employed in the dyeing and the tobacco industries. As a remedial agent it has almost been entirely replaced by the extract. Most of the liquorice is used by the tobacco manufacturers in the flavouring of tobacco. It is also consumed in a fair quantity in the candy industry. The residual matter of the root after extracting liquorice is used as a fertiliser for mushrooms and in the manufacture of loam fire-extinguishers. Only a small fraction of the drug is collected in the country, large quantities of the crude drug and its preparations are being imported. The plant is easy to grow, especially in river valleys in hot regions.

CULTIVATION.—The plant requires a soil 3 to 4 feet deep or more having a light, loamy and stone-free texture. It is usually grown continuously on the same land. Uprooting of the plant is done in November or October and this moves the soil to a depth of 2 to 3 ft. The soil is then levelled and planting ridges 2 ft. wide and 1 foot apart are marked out. The rows are enriched with farmyard manure at the rate of 15 to 20 tons per acre and the soil from the intervening spaces is drawn up over the manure to form rounded ridges whose summits are about 15 in. above the level of the alleys or spaces. The planting is done from old crowns of the lifted roots cut into pieces of 4 in. long. The plants are also produced from runners or underground stems which are cut into pieces 4 inches long, each having at least 2 buds. The planting is done in March or early April when the sets are dibbled in, being usually placed in groups of three with a space of 12 in. between each group. The centre set of every other group consists of an old crown which is placed at the summit of the ridge with the two other sets of the group on either side, approximately 10 in. apart. The crowns are covered with 2-3 in. of soil. Dry conditions at planting time and for the next two months give best chance for a good crop. If cold weather prevails in May or June, 20 to 40 per cent. of the sets may fail to grow. This forms one of the chief hazards of liquorice cultivation and in conjunction with the high costs of lifting, must weigh heavily in favour of low priced liquorice collected wild. During the summer the land is kept clean, and in November the canes are cut down to within 1 in. of the ground. Liquorice occupies the land for a period of five, or sometimes four years. Many growers intercrop for the first two years by planting carrots, potatoes or cabbages between the ridges. Uprooting is done in autumn. The main crop is raised in October, although some growers begin at the end of September, in order to secure the better prices obtained in the early market, and all lifting is finished in November. A trench 2 ft. deep is first made at the side of the ridges; then by working inwards, the soil is loosened from the root so that they can be

pulled out. A yield of two tons of roots per acre for baling, plus 3-4 cwt of trimmings or offal, is considered satisfactory.

Recently, the authors introduced the plant into Jammu and Kashmir in experimental nurseries. The plant fared well in Baramulla, Srinagar and Jammu. The analytical results of experimental harvest from the Srinagar nursery is given below:

	<i>Srinagar</i>	<i>B. P. and B. P. C.</i>
Total Ash, per cent.	9.2	Not more than 10 of unpeeled roots.
Acid-insoluble Ash, per cent.	5.6	Not more than 2.5 of unpeeled roots.
Water-soluble Extractives, per cent.	23.3	Not less than 20
Glycyrrhizin, per cent.	3.6	2 to 7
Starch, per cent.	4.6	Glucose, sucrose, starch, about 30. Garratt: starch not more than 6.

CONSTITUENTS.—The chief constituent of liquorice is glycyrrhizin, which is present in the drug in the form of the potassium and calcium salts of glycyrrhizic acid. Glycyrrhizic acid is not a glycoside since it yields on hydrolysis one molecule of glycyrrhetic acid and two molecules of glycuronic acid but no sugar. Glycuronic acid is, however, very closely related to the hexose sugars, and glycyrrhetic acid has a haemolytic action like that of the saponins. Liquorice also contains glucose (up to 3.8 per cent.), sucrose (2.4 to 6.5 per cent.), bitter principles, resins, mannite, asparagine (2 to 4 per cent.), and fat (0.8 per cent.). Glycyrrhizin is reported to be approximately 50 times as sweet as cane-sugar and its sweetness is detectable at a dilution of 1 : 15,000.

SUBSTITUTES AND ADULTERANTS.—Manchurian liquorice, which is derived from *G. uralensis* is chocolate brown in colour with exfoliating cork and differs from *G. glabra* in internal structure, the medullary rays being curved and lacunae present in the wood. It appears to contain about as much glycyrrhizin as the other varieties, but only traces of sugars. American or wild liquorice is the root of *G. lepidota* (Nutt) Pursh. which grows wild in the western part of the United States and lower Canada. It contains up to 6 per cent. of glycyrrhizin. The roots of *Abrus precatorius* Linn. commonly known as wild Liquorice, Indian Liquorice or Liquorice bush is reported to be used as a substitute for genuine roots but for its toxic properties it can not be recommended for the purpose.

PHARMACOLOGY OF LIQUORICE.—Liquorice preparations, being demulcent expectorant and pleasant tasting, have been widely prescribed as ingredients in cough mixtures and as flavouring agents. Revers in Holland noticed that patients taking liquorice preparations sometimes put on weight and developed swelling of the ankles. Further work carried on at Amsterdam University revealed that when liquorice was taken orally it caused salt and water retention while, simultaneously, there was an excessive loss of potassium. Since there was now more fluid than before in circulation, there was increased work for the heart; a higher filling pressure from the veins, an increased volume output and an increased pressure in the arteries with each beat. After some time, the circulation got adjusted back again leading to increased salt and water loss. On stopping liquorice potassium began to accumulate.

This effect is the same as that observed with desoxycorticosterone acetate (DOCA). Strong and Roussak working independently in Britain arrived at the conclusion that liquorice flavour was responsible for upset in the electrolyte balance in tuberculosis patients treated with para-aminosalicylic acid. Groen and his colleagues treated a number of patients of Addison's disease successfully with liquorice. Others, however, did not get satisfactory response. On the contrary, Borst and Moluysen found that liquorice regularly produced DOCA-like effects in normal people but not in patients with Addison's disease. Borst and Moluysen have reported recently that liquorice shows DOCA-like activity when it is administered simultaneously with cortisone. The probable explanation is that liquorice exerts its DOCA-like effect only if the adrenal gland is producing a certain minimum quantity of cortisone or related steroids.

Card has suggested that the active principle may be glycyrrhetic acid. It would, therefore, be wise to avoid the use of liquorice as a flavouring agent in patients suffering from the following conditions: heart failure, hypertension, kidney diseases, obesity, and disorders associated with pregnancy.

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HEMIDESMUS INDICUS R. Br. (Asclepiadaceæ)

INDIAN SARSAPARILLA

VERN.—Sans.—*Ananta*, *Sariva*; Hind.—*Magrabu*; Beng.—*Anantamul*; Tam.—*Nannari*; Pers.—*Aushbahe-hindi*.

Sarsæ radix is obtained from *Smilax ornata* (Liliaceæ), a climbing plant indigenous to Costa Rica, and from other similar species found in Central America. It is commonly known as Jamaica sarsaparilla because it was formerly exported by way of Jamaica to various countries. *S. officinalis* comes from Honduras, but *S. ornata* is considered to be the best commercially. The important varieties of sarsaparilla and their sources as given in the U. S. P. XIV (1950) are as follows:

Variety and Geographical Source	Synonyms	Botanical Source
Mexican	Vera Cruz or Grey	<i>Smilax aristolochiæfolia</i> .
Honduras	Brown	<i>Smilax regeli</i> .
Ecuadorian	Guayaquil	<i>Smilax febrifuga</i> .
Central American	Costa Rica or "Jamaican"	Undetermined spp.

This plant has had a vague reputation in the treatment of nutritional disorders and syphilis for ages. It is also used in chronic rheumatism, skin affections and as a blood purifier. Many of the chemical researches on sarsaparilla have been made on material of doubtful origin and it is said that much of the commercial

drug is almost inert owing to age. A sample of Jamaica sarsaparilla examined by Power and Salway (1913) contained a crystalline glycoside, sarsaponin, $C_{44}H_{76}O_{20} \cdot 7H_2O$, which yielded on hydrolysis sarsapogenin, $C_{26}H_{42}O_8$ and glucose. A tentative structural formula has been proposed for sarsapogenin by Fieser and Jacobson (1938). The drug also contained the sterols sitosterol, $C_{27}H_{46}O$, and stigmasterol, $C_{30}H_{50}O$; sitosterol d-glucoside; a new crystalline dicarboxylic acid, sarsapic acid, $C_6H_4O_6$; glucose, fatty acids, and about 1.25 per cent. of resinous matter. Recent researches have proved conclusively that the active principles of sarsaparilla consist of an enzyme, an essential oil and a saponin, none of which has any action in syphilis and other conditions for which it is used. Whilst its mode of action is obscure it may stimulate the defensive mechanisms of the body or increase intestinal absorption of other drugs. It is widely used as a vehicle (particularly in the U. S. A. where a Fluid Extract and compound syrup are official) and large quantities are employed in the manufacture of non-alcoholic drinks. Large quantities of sarsaparilla and its preparations are imported into India annually. From the reports of the sea-borne trade of India it appears that sarsaparilla to the value of Rs. 40,000/- was imported into India during 1928-33.

Two plants allied to sarsaparilla grow largely in India; these are *Saccolabium papillosum* and *Hemidesmus indicus*. The root of *Hemidesmus indicus*, known as 'Indian sarsaparilla', has long been employed in Southern India as an alterative and tonic. It is a climbing plant plentiful in Northern India, common in Bengal, and in the Deccan extending to Travancore and Ceylon; it also grows in the Bombay Presidency. In the ancient literature the plant has long been mentioned as a very important medicine. In 1831 Ashburner called the attention of medical practitioners of Europe to this plant and in 1864 it was admitted to a place in the British Pharmacopoeia. It, however, soon, lost its reputation owing to the fact that the materials sent from India were often adulterated or deteriorated in quality. However, it occupies an important place in the Indigenous system of medicine as a valuable and suitable substitute of the European Sarsaparilla which is obtained from *Smilax ornata* Hook. and other allied species. According to the difference in species, the roots of *Smilax* are known in the market as Honduras, Texas, Mexican, Jamaican, and other varieties of Sarsaparilla. The Indian Sarsaparilla of commerce is obtained from the roots of *Hemidesmus indicus*. In commerce it is met with in small bundles consisting of tortuous roots and root bits of one or more plants bound together with a wisp of the root stem.

The plant is not cultivated anywhere on a scientific basis in India as it grows wild all over the country. Agricultural methods and practices if applied to this plant is sure to bring out an improved quality of crops. The roots are consumed in large quantities in India and it was more so during the last war when the foreign supply of Imported Sarsaparilla (Import figure Rs. 50,408 in 1939-40) was stopped. The roots yield by simple distillation with water a steroptene, which is supposed to be a volatile acid. The root also contain an essential oil of which about 80 per cent. consists of a crystalline material, 2-hydroxy-4-methoxybenzaldehyde. The odour of the drug is due to coumarin. In addition, two sterols were

isolated: hemidosterol and hemidesmol. The roots also contain resins, tannin and very slight amounts of a glycoside. Clinical trials show that its medicinal value is in no way inferior to the imported sarsaparilla.

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HYOSCYAMUS MUTICUS Linn. (Solanaceæ)

HENBANE

VERN.—Hind.—*Khurasani ajvayan, Kohee bhang*; Beng.—*Khurasani ajowan*.

The seeds of hyoscyamus have been used by the Mohammedan physicians for a long time, but although it is a native of the Himalayas it does not appear to have been used in the Hindu medicine. Henbane, probably the continental *H. albus*, was known to Dioscorides and was used by the ancients. Henbane was used in England during the Middle Ages. After a period of disuse in the eighteenth century the drug was restored to the London Pharmacopoeia of 1809 largely owing to the work of Storck.

H. muticus is reported to be growing in north-western Himalayas especially in West Punjab, Sindh, Baluchistan (Pakistan) and Afghanistan. The plant has been cultivated in Saharanpur, Lyallpur and Kashmir on an experimental scale. *H. muticus* is a herbaceous perennial, 30 to 90 cm. high, branches clothed with soft woolly hairs and roots creeping exceedingly. Cauline leaves are stalked, scattered 10–20 × 5–12.5 cm., the lowest being largest. The petals of flowers are lurid yellow or nearly white. The limb is pink outside and darker pink inside, veined and often with deep purple spot at the base. The crude drug consists of dried leaves and flowering tops of the plant collected soon after the plant has flowered. There is a good trade in India in this crude drug. It is mentioned in the Indian Pharmacopoeial List, 1946 as a source of Indian Hyoscyamus and it is used as a substitute for *H. niger*. It contains higher percentage of total alkaloids than the former one.

CULTIVATION.—The plant is cultivated in India in Jammu and Saharanpur but on very limited scale. The methods of cultivation are the same as those applicable to *H. niger*. It is reported to be growing in large patches along the river banks in the West Punjab and Sind.

CONSTITUENTS.—The dried leaves and flowering tops yield from 0.5 to 1.34 per cent. of total alkaloids consisting mainly of hyoscyamine. Recently, it has also been observed here that besides Hyoscyamine it also contains 0.02 per cent. of Hyoscine. Kapoor, Handa and Chopra procured the seeds from Sudan and raised them at Jammu (1,000 ft.) and at Yarikhah (7,000 ft.). The seeds sown in Jammu germinated in 3–4 weeks and the leaves collected thereof gave on analysis 0.35 per cent. alkaloids. The seedlings raised at Yarikhah did not survive the frost. The International Pharmacopoeia requires the drug to contain not

less than 0.5 per cent. of alkaloids calculated as hyoscyamine. Ahmed and Fahmy found about 1.7 per cent alkaloids in the leaves, 0.5 per cent. in the stems and 2.0 per cent. in the flowers. The Chief alkaloid is hyoscyamine. Some anthocyanin pigment is also present.

It is indigenous to desert regions in Egypt, Arabia and Persia and Sudan and has been introduced into Algiers. In Egypt it is collected from wild plants by Arab shepherds. The export of viable seeds from Egypt is prohibited by law.

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HYOSCYAMUS NIGER Linn. (Solanaceæ)

HENBANE

VERN.—Sans.—*Parasikaya*; Hind.—*Khurasani-ajvayan*;
Beng.—*Khorasani ajowan*; Bomb.—*Khorasani-owa*;
Tam.—*Kurasaniyomam*.

H. niger or henbane is a well-known plant used for its sedative and antispasmodic properties. According to Hocking, the plant was originally a denizen of Eurasia. It is now distributed throughout Europe, from Portugal and Greece in the south to Norway and Finland in the north. It also occurs in Caucasia, Iran, Asia Minor, North America and in Siberia. In India, the plant grows in Jammu and Kashmir State, Himachal Pradesh and the Kumaon hills in Uttar Pradesh. In Jammu and Kashmir the plant grows wild throughout the valley and even at such remote places as Shankargarh, Gurikote beyond Kamri Pass (14,000 ft.) and Leh (11,000 ft.) in the inner dry valley of the North-Western Himalayas. For commercial purposes the plant is collected from around Pehalgam, Aru, Gulmarg, Shopiyan, Anantnag, Baramulla, Bandipur, etc. in the Kashmir valley. The dried leaves and flowering tops of *H. niger* are used for medicinal purposes. Henbane grows in two distinct forms, viz. (a) annual and (b) biennial.

The following difference between the growing plants of *H. niger* used for pharmaceutical preparations may be of interest:

FIRST YEAR BIENNIAL	SECOND YEAR BIENNIAL	ANNUAL
Stem very short.	Stem branched and up to 1.5 m. high.	Stem simple and about 0.5 m. high.
Leaves in a rosette near the ground. Ovate-lanceolate and petiolate up to 30 cm. long, the lamina being up to 25 cm. long. Hairy.	Leaves sessile, ovate-oblong to triangular ovate, 10 to 20 cm. long. Margin deeply dentate or pinnatifid. Very hairy, especially in the neighbourhood of the mid-rib and veins.	Leaves sessile. Smaller than those of the biennial plant, with a less incised margin and fewer hairs.

FIRST YEAR BIENNIAL	SECOND YEAR BIENNIAL	ANNUAL
Does not normally flower in the first year.	Flowers May or June. Corolla yellowish, with deep purple veins.	Flowers July or August. Corolla paler in colour and less deeply veined.

On the basis of the analysis of a few commercial samples, Forsdike and Jhonson stated that the alkaloidal content of the Indian henbane is much below the official standard. The authors collected for analysis leaves from wild and cultivated plants growing in Kashmir and other parts of India. The specimens were found on an average to contain the following percentage of alkaloids:

Drang (Kashmir), wild	....	....	....	0.076 per cent.
Gulmarg, wild	....	....	....	0.066 „ „
Srinagar, cultivated	....	....	....	0.051 „ „
N. W. F. P. wild	....	....	....	0.047 „ „
Lyallpur, cultivated	....	....	....	0.025 „ „
Saharanpur, cultivated	....	....	....	0.035 „ „
Jammu, cultivated	....	....	....	0.044 „ „

Thus it is seen that hyoscyamus leaves collected from wild or cultivated plants in Kashmir at an altitude of 5,000 ft. or above have alkaloidal contents well up to and even above B. P. or U. S. P. standards (0.051–0.076 per cent). The alkaloidal content of the leaves at lower altitudes or in the plains at Saharanpur, Lyallpur or in the N. W. F. P. (Pakistan) is much below the official standards. This is further supported by analytical data of bulk samples of the drug carried out at the Drug Research Laboratory (Manufacturing Section) during the past several years. The entire crop for processing came from Kashmir. The alkaloidal contents of the crops for the past several years are stated below :

1945	....	....	0.058 per cent.
1946	....	....	0.062 „ „
1949	....	....	0.049 „ „
1950	....	....	0.044 „ „
1951	....	....	0.051 „ „

The present output of the drug from natural sources in Kashmir is limited and falls much below the growing demand of the pharmaceutical industry in India and a considerable quantity of the drug and its preparations are, therefore, imported. Collection from distant scattered habitats entails heavy expenditure and the yield of the active principles is variable.

CULTIVATION IN INDIA.—The first record regarding the cultivation of *Hyoscyamus* in India according to Watt is made by Royle in 1839. He reported that henbane was successfully grown and converted into extracts for medical store depots at several stations in the plains of India. Later records show that it was successfully cultivated in Calcutta, Saharanpur, Agra, Ajmer, Bombay and the Nilgiris. Subsequently cultivation dwindled and most of the *Hyoscyamus* required for home consumption was imported from Europe. Even the seeds (*Ajwain Khorasani*) were imported from Iran and Kabul.

Jammu and Kashmir: To supplement the present supply position of *Hyoscyamus*, its cultivation on an experimental scale was started at a number of nurseries in Jammu and Kashmir by the Forest Department in collaboration with the Drug Research Laboratory in areas where the drug with a high alkaloidal content occurs. The leaves collected from these nurseries at the time of flowering had the following alkaloidal contents:

Drang (7,500 ft.)	....	....	0.084 per cent.
Yarikhah (7,000 ft.)	....	....	0.081 " "
Srinagar (5,000 ft.)	....	....	0.051 " "
Baramulla (5,500 ft.)	....	....	0.044 " "
Jammu (1,000 ft.)	....	....	0.044 " "

It has been observed that levelled area, free from weeds is suitable for henbane cultivation. A well-drained fertile sandy loam or silt loam is also considered favourable for *hyoscyamus* farming. Slopy areas do not give a uniform crop, there being thicker growth at lower levels due to the seed being washed down from the top.

Propagation of the plant is done by broadcasting the seed or by first raising it in nurseries and then transplanting in the field. The seed is sown broadcast in prepared soil at the rate of 2-3 lb. per acre in spring or in July-August. As the seed is very small, it is preferable to mix it with fine dry earth before sowing. When sown by a drill, the rows are kept 2 ft. apart. The seed is not covered by more than $\frac{1}{4}$ in. of soil; if the weather is favourable, the seed germinates in 3-4 weeks in spring and in 2-3 weeks in mid-summer. It is said that the seeds germinate more satisfactorily if they are first treated for 75 seconds with concentrated sulphuric acid and thoroughly washed with water. Fairly uniform germination is then said to take place in twelve to fifteen days. The plant may be attacked by the potato beetle, and spraying with derris or pyrethrum may be necessary. The crop is harvested by hand picking the leaf in June-July at the time of flowering. The annual dies after the seed matures, but the biennial remains dormant under the snow after the first year's harvest. In spring, it gives a tall branched stem with several leaves which are harvested at the time of flowering, viz., June-July. The seeds mature in September-October and are harvested by cutting the whole plant with a sickle or pulling out by the hand. It has been observed that *H. niger* (biennial) gives better yield per acre if propagated by the broadcast method.

H. niger is also cultivated at Jammu (1,000 ft.) and in the plains of India (Saharanpur) as a winter crop. The seed is sown broadcast by drilling in lines 2 ft. apart in well-prepared soil. When the seed germinates, weeding, hoeing and other operations are carried out. The plant requires irrigation in early stages of its growth. The popular belief that the annual contains higher alkaloid content than that of the first year leaves of the biennial has been found to be incorrect. The samples of leaves from the biennial and the biennial crops raised by transplanting and broadcast sowing at Yarikah (7,000 ft.) were analysed and no marked difference in their alkaloidal contents was observed. Fresh *hyoscyamus*

leaves contain a large percentage of moisture and should be thoroughly dried before packing. Collection made during early spring contains about 90 per cent. moisture which in later months (September–October) falls to 70–80 per cent.

YIELD.—The average yield of the crop depends upon a number of factors, viz., the nature of the soil and the climatic conditions, irrigation, weeding, etc. It has been observed that forest soils or waste lands rich in organic manure give a good yield of the crop. No reliable data have, however, been collected regarding the yield of crop per acre. At the Drug Farm, Yarikhah, 2–3 mds. of dry leaf crop per acre were obtained. On an experimental scale the yield can be increased up to 5–6 mds. of dry crop per acre if the soil is ploughed three to four times and weeding, irrigation, etc., are carried out at regular intervals.

THE SEED.—The seed is harvested in October–November when the whole plant is uprooted before the capsule dehisces itself. A single plant yields 10,000 seeds per harvest. Seeds kept dry, remain viable for several years. Henbane seeds are dark-gray in colour, somewhat reniform in shape, and about 1.5 mm. long. They have a minutely reticulated testa and an internal structure closely resembling that of stramonium seeds. Henbane seeds contain about 0.06 to 0.10 per cent. of alkaloids (hyoscyamine with a little hyoscyne and atropine).

ALKALOIDAL CONTENT OF THE DRUG.—The British Pharmacopoeia (1948) lays down that the drug should contain not less than 0.05 per cent. of alkaloids; according to United States Pharmacopoeia (XIII), the drug should contain not less than 0.040 per cent. of alkaloids. A number of samples collected from the Drug Farm gave the following values for the alkaloidal content (per cent.): 0.063, 0.057, 0.0475, 0.057, 0.044, 0.081, 0.092, 0.062, and 0.066. It is thus seen that cultivated plants improve in their alkaloidal contents. Attempts have also been made to procure seeds of *hyoscyamus* from abroad for cultivation in India and for making comparative study with the local variety. The plants raised from the seeds obtained from U.S.A., Turkey and Oxford through the courtesy of UNESCO had the following alkaloidal contents: U. S. A., 0.063; Turkey, 0.062; Oxford, 0.059 per cent. It is thus seen that the plant produced in Kashmir by cultivation compares favourably in its alkaloidal content with that grown in the western countries. Hyoscyamine is the chief alkaloid present, but it may be accompanied by a little hyoscyne and atropine. The petiole appears to contain more alkaloids than the lamina or stem.

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IPOMÆA HEDERACEA Jacq. (Convolvulaceæ)

VERN.—Hind. and Beng.—*Kaladanah*, *Mirchai*; Bomb.—*Kaladanah*; Tam.—*Jirkivirai*; Punj.—*Bildi*.

IPOMÆA TURPETHUM R. Br. (Convolvulaceæ)

VERN.—Sans.—*Trivrit*; Hind.—*Pitohri*, *Nisoth*; Beng.—*Teori*; Bomb.—*Nishotar*; Tam.—*Shivadai*; Punj.—*Chitabansa*.

I. turpethum or Turpeth has long been used in India as a cathartic but it was not officially recognised in the pharmacopoeias. It is found throughout India, ascending to altitudes of 3,000 ft. The resinous substance (turpethin) which the root bark of this plant yields is an excellent substitute for jalap (*I. purga*).

The seeds of *I. hederacea* (kaladana) have also been credited with a purgative principle and have been used as a substitute for official jalap. Many early European workers have testified to the utility of the powdered seeds of *I. hederacea* in constipation. In spite of this, *I. purga* or *I. muricata* are imported either from Europe or Persia in large quantities and are found in Bombay. The properties of the indigenously growing Ipomæas were not sufficiently recognised in the early days and in view of its great demand attempts were made at that time to cultivate the true *I. purga* from the Mexican Andes in India. It was actually introduced into the Himalayan valleys in the middle of the nineteenth century but the experiment did not prove a success, in any case the yield was not up to the expectation and was not enough to supply the demands. In the Ootacamund gardens the plant grew better and gave better promise of a fair return on the outlay, even at the price allowed by the Medical Stores Depot which was much below the usual market price. The cultivated jalap was found to be as rich in the purgative resins as the best kinds imported from South America. In spite of the fact that good substitutes for jalap exist in India and grow in a state of nature and that the official *I. purga* can be successfully grown in different places of India, this country imported large quantities of *I. purga* from Mexico. The requirement of jalap is very large indeed as it is one of the most commonly used amongst the drastic purgatives of the Pharmacopoeia.

One of the factors which militated strongly against the popularity of *I. turpethum* was the adulteration and substitution practised frequently by the drug vendors of India. Most of the turpeth available in the market consists of aerial stems or a mixture of stems and roots, and not of the roots which alone are rich in the purgative principle. *I. turpethum* is now recognised in the Indian Pharmacopoeial List, 1946, where the dried roots of the white variety with the bark intact is official. It contains not less than 5 per cent. of resin, a part of which is soluble in ether. Similarly the dried seeds of *I. hederacea* Jacq. (Kaladana) are made official in the Indian Pharmacopoeial List 1946.

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JUNIPERUS COMMUNIS Linn. (Cupressaceæ)

VERN.—Hind.—*Aaraar*; Punj.—*Petthri*, *Pama*; Kash.—*Bentha*, *Pethra*; Arab.—*Habbul-aaraar*.

Juniper berries and the oil extracted from them are very ancient remedies and were known to the ancient Greeks. They used the drug for its diuretic as well as its digestive properties. *J. communis* occurs widely throughout Europe, Siberia, India and North America. The Italian berries, however, are most valued for their oil. The extraction of the oil for medicinal and commercial purposes is done in Hungary, Italy, Russia, Bavaria and Sweden. Hungary is the chief country of production and a considerable external trade exists in this oil. In India, several species of Juniper are found in the Western Himalayas, Kumaon and the Kurram valleys at an altitude of 11,000 ft. above the sea level. They do not appear to be much used in medicine locally, though the berries are sold in the bazars by the Mohammedan druggists. Simonsen studied the oil from the berries of *J. communis* obtained from the upper Bashahr division and found that about 0.2 per cent. of the oil could be obtained. Handa and Kapoor obtained 0.77 per cent. oil from the berries of *J. communis* from Kashmir. This yield is low as compared with the yield from the other continental plants; thus the Italian berries yield 1.0 to 1.5 per cent., Bavarian 1.0 to 1.2 per cent., Hungarian 0.8 to 1.0 per cent., Swedish 0.5 per cent., Polish 0.9 per cent., Thuringian 0.76 per cent., East Prussian 0.6 per cent.

Besides the volatile oil the juniper berries contain invert sugar (about 33 per cent.), resin (about 10 per cent.), a bitter principle, organic acids and their salts and wax. Oil of juniper contains the terpenes α -pinene and camphene, the sesquiterpene cadinene, at least two terpene alcohols, one of which is terpineol and traces of esters. On cooling old samples of oil of juniper, a crystalline substance 'juniper campher' is deposited. The Indian juniper oil corresponds closely to the foreign varieties except in certain constituents which have been given below:

	Hungarian	Italian	Indian
Specific gravity at 20°	0.867	0.866	0.8788 (at 30°)
Optical rotation	—12°	—9.82°	not determined as the oil is dark
Saponification value	5.9	6.1	21.2
Saponification value after acetylation	20.9	21.3	49.1

The differences might probably be accounted for by the particular liability of juniper oil to change on keeping. The differences are minor and the Indian oil possesses practically the same proportion and character of the alcohol and esters to which the flavour of the oil is chiefly due.

Two species of Juniper commonly growing in Kashmir, namely *J. communis* Linn. and *J. macropoda* Boiss. were tested by the senior author. In general appearance, there was not much difference between them in their berries excepting that the latter are somewhat longer in shape. The amount of volatile oil obtained by steam distillation was 0.25 per cent. and 3.24 per cent. respectively from *J. communis* and *J. macropoda*. The colour, odour and solubility

of the oils were almost the same as that of the official oil of juniper. The oil from *J. macropoda* showed some difference in optical rotation and other minor physical properties. The characteristics of the oil are given below for comparison with the standard laid down by the British Pharmacopoeia:

		<i>J. communis</i> (B. P. Standard)	<i>J. macropoda</i>
Optical rotation	....	-3° to -15°	-24.3°
Specific gravity	....	0.86 to 0.89	0.912

Handa and Kapoor also studied the berries of *J. communis* and *J. macropoda* obtained from Kashmir Forests with the following results:

		Yield of Oil	Sp. Gravity	Refractive Index
<i>J. communis</i>	....	0.77 per cent.	0.9388 at 15°C.	1.488 at 20°C.
<i>J. macropoda</i>	....	3.3 per cent.	0.8571 at 15°C.	1.473 at 20°C.

In spite of the similarity in the physical and chemical properties which the Indian oil shows, very little attempt has been made to utilise the juniper berries or the juniper oil in commerce. Juniper berries are rich in sugar and by their fermentation and distillation the well-known beverage 'gin' is obtained which owes its characteristic flavour to the oil of juniper. There appears to be a large demand for the berries in the western markets. The possibilities existing in this direction in India are worth exploring. Both of these species are recognised in the Indian Pharmaceutical Codex 1952, Indian Pharmacopoeial list 1946.

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MENTHA ARVENSIS Linn. (Labiatae)

VERN.—Hind.—*Pudinah*; Beng.—*Pudina*; Bomb.—*Pudinah*; Tam. and Tel.—*Pudina*; Pers.—*Pudinah*.

A number of *Mentha* species indigenous to Himalayan regions grow wild in India but a few exotics have also been introduced successfully. Amongst the indigenous species *M. arvensis* Linn., *M. sylvestris* Linn. and its var. *incana* Hook. f. and var. *royleana* Hook. f. may be mentioned. *M. viridis* Linn. (Spearmint), *M. piperita* Linn. (peppermint) and *M. aquatica* Linn. have been introduced and are well established in India. Very recently attempts have been made to introduce the Japanese Peppermint plant (*M. canadensis* var. *piperascens*.) which appears to be a promising addition to the existing *Mentha* species.

M. arvensis grows in the northern and western Himalayas in a state of nature. It is found in Kashmir at an altitude of 5,000 to 10,000 ft. The drug was well-known to the Greeks and Romans and was used not only for

flavouring foods but also for medicinal purposes. Although many species of this plant grow in India the Hindu physicians do not appear to have used it in their medicine. *M. arvensis* is, however, now used as a domestic remedy in India on account of its stimulant and carminative properties.

M. arvensis growing in the Himalayas yields an oil which is similar to the peppermint oil derived from the official *M. piperita*. Peppermint oil (oleum menthæ piperitæ) is largely used in India in pharmaceutical preparations to disguise the taste of evil-smelling and unpleasant drugs and also as a carminative. As a flavour in confections and dentifrices also it is used to a very large extent. It has, therefore, some economic importance. The essential oil obtained from *M. arvensis* by steam distillation compares very favourably with the oil obtained from *M. piperita*. The oil has the same odour, taste and other physical characters as the peppermint oil used in the British Pharmacopoeia, and crystals of menthol can be easily obtained from it on keeping for some time. The amount of essential oil obtained from the whole dried plant from Kashmir was 0.18 to 0.2 per cent. This compares favourably with the average yield from some of the American sources, as will be seen from the following statements:

Source	Yield of Oil
Arlington Farm (America)	0.12—0.13 per cent.
Webster, South Dakota (America)	0.10 " "
Glennedale (America) ———	0.11 " "

It is likely that specimens of fresh herb will give a higher percentage of oil than that obtained from the dry herb extracted in India, as it is stated by some authorities that the drying of the herb before distillation results in a loss of 50 per cent. of the oil.

As a result of extensive researches carried out by the United States Department of Agriculture, it has also been found that if the leaves are collected during the budding and flowering stages, the yield of oil on distillation is much higher than the figures given above. The following figures show some of the results obtained by the American workers:

Stage	From Entire Plant per cent.	From Leaves Alone per cent.	From the Tops per cent.
Budding —	0.116	0.203	0.173
Flowering —	0.113	0.303	0.233
Fruiting —	0.133	0.120	0.153

It is, therefore, quite probable that if similar precautions are taken with regard to the Indian plant, the yield of oil will be still further improved. Chopra, Handa and Kapoor obtained 0.45 per cent. essential oil from the leaves of *M. arvensis* growing in Kashmir with specific gravity 0.9161 at 15°C., and refractive index 1.474 at 20°C., but no menthol could be isolated from the oil.

CULTIVATION.—The plant prefers calcareous soil, friable sandy loams or gravels and it is grown with success from cuttings. The plants are quite hardy and require no special process for cultivation.

PRODUCTION.—The drug has a good demand in Indian market due to its chief use as flavouring vegetable. No attempt has been made for production of oil in India and India consumes imported stuff.

The oil of *M. arvensis* (Pudina oil) is official in the Indian Pharmacopoeial List 1946.

M. piperita can be easily grown as a garden plant in temperate climates. Its cultivation is not difficult and requires only the usual attention given to such crops as corn, potatoes, etc. Any marshy soil situated along the banks of rivers, provided it is dry and well-drained, is suitable. According to a report by the Ministry of Agriculture, London, any light calcareous soil, friable sandy loams or gravels may be used for cultivation of mint. Soils of the above description are not difficult to find in a vast country like India. Many years ago experiments were carried out with a certain degree of success in growing the plant in the Nilgiri gardens for the purpose of obtaining the oil. An excellent quantity of oil was obtained and there is no reason why this industry should not be successfully developed. The methods of planting, cultivating, harvesting and distilling have been worked out through years of trial and experiment in other countries and could be easily taken advantage of in India.

Recently, the plant has been raised in Mysore and also at the Forest Research Institute, Dehra Dun. Rooted suckers of this plant procured from the Punjab Agricultural College, Layallpur, were propagated in Kashmir at Baramulla (5,500 ft.), Srinagar (5,000 ft.) and at Yarikhah (7,000 ft.) in spring; these reacted favourably to the soil in all these places. The flowering tops and leaves collected from these nurseries in August were steam distilled and the results are given below:

Yield of the oil from plants raised at:	Percentage of Oil and other constants	B. P. C. Standards
(1) Yarikhah 7,000 ft.	0.7 to 1 per cent. on the basis of dry leaves.	Not less than 0.5 per cent.
(2) Baramulla 5,000 ft.	0.7 per cent.	Do.
Specific gravity at 15°C	0.9187	0.897 to 0.91
Refractive index at 20°C	1.466	1.466 to 1.47
Solubility	Sol. in 6 vol. of 70 per cent. alcohol.	4 vol. of 70 per cent. alcohol.
Percentage of menthyl acetate	14.4 per cent.	4 to 9 per cent.
Percentage of menthol	46.6 per cent.	Not less than 46 per cent.

ECONOMIC ASPECTS.—Peppermint oil of commerce is derived chiefly from two botanical sources: (1) The English and European oils from *M. piperita* var. *vulgaris* Sole., 'black mint' and *M. piperita* var. *officinalis* Sole., 'white mint' and (2) the Japanese oil from *M. arvensis* var. *piperascens* Holmes or from *M. canadensis* var. *piperascens* Briquet. Peppermint of U. S. P. consists of the dried leaf and flowering tops of *M. piperita* Linn. English peppermint oil occupies a unique position. It is admittedly superior to any other kind and commands a much higher price. Much adulteration of the English with American oils takes place.

CONSTITUENTS.—Oil of peppermint contains from 4 to 14 per cent. of esters calculated as menthyl acetate, and not less than about 46 per cent. of free menthol.

Some of the characters of commercial oils are indicated below and should be compared with the official requirements.

	<i>American</i>	<i>English Black Mint.</i>	<i>English White Mint.</i>
Specific gravity	0.900 to 0.915	0.9036	0.9058
Optical rotation	-18° to -35°	-23.5°	-33°
Menthol, as esters	5 to 14 per cent.	3.7 per cent.	13.6 per cent.
Menthol free	45 to 50 per cent.	59.4 per cent.	51.9 per cent.
Menthone	9 to 19 per cent.	11.3 per cent.	9.2 per cent.

Japanese oil has a strong, characteristic, herby odour and a somewhat pungent taste, and these properties readily distinguish it from the English and American oils. It is rich in menthol content and readily crystallises to an almost solid mass on cooling. According to Trease, natural Japanese peppermint oil contains from 70 to 90 per cent. of menthol, for the extraction of which it is largely used. The dementholised Japanese oil of commerce contains approximately the same amount of menthol and its esters as the American oil. It is very largely used, as will appear from the total exports figures from Japan in 1926:

Peppermint oil	....	....	....	637,203 lb.
Menthol	....	....	....	705,371 „
Menthol pencils	....	....	....	176,668 „

The cultivation of peppermint in the United States began as early as 1816 and is zealously carried on even to this day. The plant is scientifically cultivated mostly along the Pacific coast and the production of mint has reached a satisfactory figure. The annual production of peppermint oil in the United States in the period 1935 to 1947 ranged from 1,000,000 to 1,600,000 lb. obtained from 35,000 to 50,000 acres. In Indiana, Oregon, and Washington the acreage of peppermint and the production of oil have increased steadily as the annual consumption of the oil has increased. Average yield of oil per acre varies between 30-40 lb. America not only supplies her own somewhat extensive needs but also carries on a huge export trade in the oil.

Both Japan and the United States derive a large profit from the sale of peppermint oil. England, France, Italy and Germany also possess flourishing industries in mint oil. Australia recently has been experimenting somewhat extensively on the production of oil of peppermint and the published reports indicate very favourable results. Within the last few years, cultivation of peppermint has been taken up in Roumania on an experimental scale and it is said that the experiment has succeeded remarkably. In view of the large natural resources existing in India and in view of the fact that the average price for peppermint oil is steadily on the increase, India should not remain behindhand in this industry. Cultivation of mint in suitable localities and distillation of the oil in India for commercial purposes is certainly a remunerative enterprise, well worth taking up.

The essential oil Advisory Committee of the C. S. I. R. observed in their Exploratory Report (1946): "India imports about Rs. 75,000 worth of peppermint oil annually. There is no reason why it should not be possible to cultivate peppermint plants in India. Peppermint oil is an important member of the Essential oil family and has uses in the pharmaceutical and confectionery industry.

We are of the opinion that the peppermint plants of suitable varieties may grow well at altitudes of 4,000 to 5,000 ft. if selected plants are introduced at these heights." Recently, *M. canadensis* var. *piperascens* from Japan was introduced in Jammu (900 ft.) by the authors in 1953. It has shown remarkable adaptability to the local soil and other climatic conditions. The plant in the nursery yielded 2.1 per cent. essential oil from dry leaves with 70.1 per cent. free menthol. The plant is being extended for further propagation. Large quantities of menthol are being produced synthetically. This process is easily carried out by reducing ketones such as menthone, pulegone and piperitone. Piperitone is contained in eucalyptus oil and to a certain extent in the dementholised oil produced in Japan and can be easily converted into menthone, which in its turn can be changed by catalytic hydrogenation into menthol. The product by this method is what has been appearing during the past several years on the market as synthetic menthol.

Pulegone is the principal ingredient of pennyroyal oil, (*M. pulegium*) and will be found to a noticeable degree in the Japanese peppermint herb. Like piperitone, this can be changed into menthone. Citronellal, much of which is found in citronella oil (from citronella grass, *Cymbopogon nardus*) produced in Java and Ceylon, can also be used in the preparation of menthol.

According to Schimmel & Co's reports synthetic menthol produced in their laboratories is laevo-rotatory with a melting point of 35°C and in appearance and odour it is very similar to the natural menthol. Tests have further shown that the synthetic product is slightly more active physiologically but less toxic than the natural product. Its antiseptic properties are similar to many of the following drugs, e.g., acriflavine, scarlet red, gentian violet, etc. As matters stand at present, it is not possible to forecast the possibilities of the natural menthol industry.

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MYRISTICA FRAGRANS Houtt (Myristicaceæ)

THE NUTMEG, MACE

VERN.—Sans.—*Jati-phalam*; Hind. and Beng.—*Jayphal*, *Jaiphal*;
Bom.—*Jaiphal*; Tam.—*Jadikkay*; Tel.—*Jajikaya*.

Myristica malabarica Lam.

BOMBAY MACE

Myristica or nutmegs are not very much used in medicine but the volatile oil derived from them enters into several important and widely used pharmacopoeial

preparations like spiritus ammoniæ aromaticus, tinctura valerianæ ammoniata, etc. The nutmeg oil is also used externally for rheumatism. The oil is also used in aperient pills and other preparations to prevent griping and is given on sugar as a stimulant and carminative. Apart from purely medical use, the nutmegs form an important article of commerce in that the essential oil is highly prized in the soap and perfumery industry.

Nutmegs are the dried kernels of the seeds of *M. fragrans*, an evergreen tree about 10 to 20 m. in height indigenous to Molucca Islands. The tree grows also in Penang, Sumatra, Singapore, Ceylon and the West Indies and has been introduced into Mauritius, Bourbon, Madagascar, the Seychelles and Zanzibar. Grenada (West Indies) now supplies about half of the nutmegs used in the U. S. A. Several species are found in India in the Nilgiri Hills and the Malabar coast. It appears from ancient records that the nutmeg tree flourished in India at one time. As early as the sixteenth century, Garcoa de Orta, a Portuguese physician found nutmeg trees growing luxuriantly in the Indian soil, but at present these are never found in abundance. A variety of nutmeg, *M. malabarica* is available in large quantities in Bombay but is deficient in that delicate aroma which characterises the *M. fragrans* and consequently of very little commercial value. It is known as 'Bombay mace' and is used as an adulterant for *M. fragrans*. The economic importance of the oil of nutmeg may be estimated from the fact that, the United States alone, on an average imports between 20,00,000 to 30,00,000 lb. from foreign countries annually. Moreover, nutmegs worth Rs. 6,62,667 were imported into India in the year 1928-29, so that if better attention is paid India might not only supply her own demands but have the prospect of an export trade of some consequence.

CULTIVATION.—*M. fragrans* can be usefully cultivated near the sea along the eastern and western coasts of India. It grows in widely different types of soil, e.g., rich volcanic sandy soil in Moluccas, to yellow, loamy clay in Penang.

In south India at present an area less than 300 acres is under cultivation of nutmeg tree. The tree grows up to 49 ft. at an elevation of 3,000 ft. To make India self-sufficient an area of 1100 acres would be sufficient to produce about 2500 cwt. of nutmeg annually. For successful cultivation of nutmeg well-drained sandy loam, and laterite soils are suitable. The soil pH should be 7.1 to 7.2 with 66 to 75 in. rainfall annually.

Generally seeds are used for sowing. Fresh seeds collected from fruits which have burst on the tree are sown within 24 hours under shade. The method gives 98 per cent. germination. The seedlings attain a height of 6-9 in. in 6 months when they are transplanted in their permanent quarters at 25-30 ft. apart, half compost mixed with 50 lb. well rotted farm yard manure per tree is found very helpful. The tree becomes productive at the age of 6 to 7 years and remains so for 30-40 years. In one case 90 years old tree is found still productive. Usually 15-20 lb. of nutmegs and 1 lb. of mace are collected from each tree. But 40 lb. nutmegs and 12 lb. mace per tree is also recorded. Mace is the aril covering the seed and is used as a spice.

COMPOSITION.—Nutmegs yield from 5 to 15 per cent. of volatile oil and from 30 to 40 per cent. of fat; also phytosterin, starch, amyloextrin, colouring matter, and a saponin. They yield about 3 per cent. of total ash and about 0.2 per cent. of acid-insoluble ash. The volatile oil (*Oleum Myristicae* B.P.) contains, according to Power and Salway, pinene and camphene 80 per cent., dipentene 8 per cent., alcohols about 6 per cent., myristicin about 4 per cent., safrole 0.6 per cent., and eugenol and isoeugenol 0.2 per cent. By expression or by means of solvents nutmegs yield a product known as "nutmeg butter" or expressed oil of nutmegs. This consists of 12.5 per cent. of volatile oil, 73 per cent. of trimyristicin (the glyceride of myristic acid), small quantities of oleic, linoleic and other acids, and about 8.5 per cent. of unsaponifiable matter.

References:—

(1) Finchemore, 1926, *The Essential Oils*; (2) Trease, G. E., 1952, *Text Book of Pharmacognosy*, 248; (3) Private Communication, Director of Agriculture, Madras.

PAPAVER SOMNIFERUM Linn. (Papaveraceæ)

THE OPIUM OR WHITE POPPY

VERN.—Sans.—*Ahiphena*; Hindi.—*Afm*, *Afiyun*; Beng.—*Posto-dheri*; Bomb.—*Aphim*, *Appo*; Tam.—*Abini*, *Gashagasha*; Pers.—*Afiun*, *Khash-khash*; Arab.—*Afiun*, *Qishrul-khash-khash*.

P. somniferum var. *album* DC. or the opium poppy grows in any part of India. It has white flowers and white seeds called *Khaskhas* the poppy capsules are called *postdoda*. It is generally cultivated and does not occur in a state of nature. Probably the plant is not indigenous to the country but was imported. It is clear from historical records that its introduction dates long before the British rule was established. The properties and uses of the capsules of the opium-yielding poppy were known long before the Christian era. According to De Candolle, *P. somniferum* or opium-yielding poppy is probably the cultivated state of *P. setigerum* a truly wild form. Various species of the poppy have been cultivated as ornamental garden plants and have been mentioned by the writers from the earliest times. There is little doubt that the merits of the seed as a food were recognized much earlier than the somniferous property of the capsules and it is also certain that the soporific and narcotic properties of the capsules themselves were appreciated long before their recognition in its milky sap. The capsules have been employed in the preparation of soporific drugs or in the preparation of stimulating and soothing beverages from times immemorial. According to Watt, *P. somniferum* was grown in Asia Minor many centuries ago for its capsules, and the Arabs carried the dried poppy heads to the eastern countries including China even before the inspissated juice was taken and its properties made known to the inhabitants of those regions. The medicinal properties of the plant and its capsules were fully known during the early classic period of Greece and Rome. One of the earliest references to opium appears to be about the time of Theophrastus who lived in the beginning of the third

century B. C. and who seems to have been acquainted with the preparation and uses of the juice of the poppy. There appears to be no doubt that the value of the seeds and capsules was known prior to that. The Egyptians used poppy capsules in the first century A. D. The early Chinese works mention the Arabs exchanging poppy heads with Chinese merchants. When the capsules were first shown to them, their urn-like shape and millet-like seeds suggested the name *minang* (millet vessel) and *yingsu* (jar millet). There are records to show that the Arabs instructed the Chinese to prepare from these capsules a soporific beverage and medicine before they knew anything about the properties of opium. There appears to be no doubt that the word *ya-pien* (Opium) followed the word *mi-nang*.

It will thus be seen that the capsules of the poppy attracted the attention of the human race long before opium was known. Little wonder then that after their narcotic and soothing properties were appreciated by those practising in the healing art, they became known to the laity who made use of them for purposes of satisfying the almost universal desire which human beings possess for a stimulant or a sedative.

MEDICAL USES OF POPPY CAPSULES.—Poppy heads are not commonly used nowadays in medicine but we have referred to their employment for medicinal purposes in the early classic Greek and Roman periods as well by the Egyptians during the reign of the later dynasties. The capsules have been used in the Hindu medicine and in the Mohammedan medicine for many centuries as a sedative both for internal use and external application. The Hakims perscribe them for headache, diarrhoea, dysentery and digestive troubles in children. They are used as a household remedy in many parts of India and are given during the teething periods by mothers to their children to keep them quiet. An infusion prepared from the poppy heads is used as a soothing application for bruises, inflamed, excoriated and swollen parts and sometimes as an application for various forms of painful conjunctivities, inflammation of the ears, etc. Fomentations with poppy heads are even now applied to painful inflammatory swellings. Even in China the physicians used them freely in the early centuries of the Christian era. Most of the Lung dynasty medical writers and from them downwards extol the merits of poppy capsules in the treatment of dysentery, especially when combined with astringent drugs. The Chinese writer Wang-Shih said that the effects of poppy capsules in dysentery were magical. According to Dr. Edkins both the red and white forms of poppy were certainly described and used in the Chinese medicine in the eleventh century before opium was known. A medical author of the Yuan dynasty (thirteenth century) describes the preparations of poppy capsules as being a very effective remedy against dysentery.

USE OF POPPY CAPSULES FOR EUPHORIC PURPOSES.—It is well-known that the use of articles of stimulative, restorative or sedative character, is bound up with the natural history of human beings from the very earliest times. The use of such articles as cocoa, coffee, tea, opium, alcohol, etc., to procure an added feeling of pleasure has been known long before the history of civilization. All of them, in moderate quantities, produce a favourable effect on mental conditions of man. They all produce an enhanced sense of well-being or euphoria. The capsules of the poppy were used very early for this purpose. Whatever might have

been the case in the countries of its origin (e.g., Asia Minor) there appears to be little doubt that poppy heads began to be used for euphoric purposes in India soon after the introduction of the poppy plant in the country. The plant was known as *koknar*, the capsules were called *goza*, *khol-i-koknar* or *post-i-koknar* or simply *post* or *postdoda*. In the time of the Moghuls a beverage made from the poppy capsules known as 'kuknar' was very commonly used throughout the country. Abul-Fazl in his *Ain-i-akbari* mentions about the Emperor himself taking this drink. He says, "Whenever His Majesty is inclined to drink wine, or take opium, or kuknar, trays of fruit are set before him". The use of the word 'kuknar' apart from opium in the above passage shows that both the poppy capsules and the inspissated juice of *Afyun* were used. According to Watt, the beverage 'post' at present taken in the Punjab closely resembles 'kuknar' which was a luxury among the Mohammedans in the time of Akbar. There is also mention of a beverage known as 'Char-bughra' which was a mixture of wine, hemp, opium and poppy capsules. Many other references in the Moghul literature indicate the extent to which the habit of drinking 'post' or 'kuknar' prevailed among the Indians during the sixteenth century and later. Bontius, writing of Batavia in 1658, divided the Indians into 'Posti', i.e., those addicted to poppy capsules and 'Afyuni' or those taking opium. During the Seventeenth and Eighteenth centuries the use of 'post' was very prevalent as is evident from the remarks of various writers of that period. The people in those days grew poppy and used it in any way they liked; the use of the capsules for euphoric purposes appears to have been very prevalent for that reason. In the history of the Punjab during the time of the Sikhs there are many references to 'post' drinking, but it is impossible to form an idea as to the extent to which the habit prevailed among the people. Since the introduction of restrictions in the cultivation of the poppy the temptation has been undoubtedly removed from the doors of the peasant and there is no doubt that habit has considerably decreased for that reason. Poppy heads are obtained now with difficulty and in most parts of India the beverage 'post' or 'kuknar' has become unknown and appears to have been replaced by opium. It has thus come about that the use of poppy capsules or 'post' has become very uncommon in the country. It is still indulged in some districts of the Punjab, chiefly Jullunder and Hoshiarpur, and in some districts of Rajasthan and Madhya Bharat.

COMPOSITION.—The capsules when unripe yield opium; when ripe and dry they contain only small quantities of the alkaloids and therefore, their narcotic properties are mild. The morphine content in the capsules (without seeds) varies very greatly; the highest found was about 0.5 per cent. Unripe capsules (in August without seeds) showed 0.050–0.020 per cent. of morphine and 0.0113 to 0.0116 per cent. of narcotine and codeine; ripe capsules (in September without seeds) showed the presence of 0.017 per cent. of morphine and 0.028 per cent. of narcotine and codeine. The amount of total alkaloids in the unlanced capsules from Indian sources was found to be 0.4 to 0.6 per cent. and in the lanced capsules 0.15 to 0.22 per cent. The seeds of *P. somniferum* were found by Kerbosch to contain traces of narcotine and of amorphous alkaloids, while Muller could not find any alkaloid in the seeds tested by him.

OPIUM.—Opium is the air-dried, milky exudation obtained by incising the unripe capsules of *P. somniferum*. The standard product in its normal moist condition contains not less than 9.5 per cent. of anhydrous morphine but the yield may vary from 2.0 per cent. to 22 per cent.

The earliest mention of opium, as a product of India, was made by the traveller, Barbosa, in his description of the Malabar Coast in 1511, and the Portuguese historian, Pyres, in a letter to King Manuel of Portugal in 1516 spoke of opium of Egypt and Bengal. An excellent account of the history of the cultivation of the poppy and of opium eating and smoking is

given by Watt in his *Dictionary of the Economic Products of India*. The author traces the history of the poppy from the time it was grown as a garden plant even before Greece and Rome knew anything about its medical properties. He states that the Swiss lake-dwellers of the Stone Age cultivated a poppy which is nearer to *P. setigerum*. The investigations of Unger (1857) have failed to show that the ancient Egyptians knew of the properties of the poppy juice, nor is there any reference to opium in Egyptian literature. It seems probable that the Greeks were the first to discover opium. The word 'Ophion' in the Talmud is clearly borrowed from the Greek, and the Arabic word 'Af-yun' has the same origin. The original home of the poppy was probably Asia Minor and from there it appears to have been carried to Greece. Homer and Livy knew the medicinal properties of the plant and Dioscoroides, who lived in the first century A.D., described in detail the extraction of opium. By the beginning of the Christian era, opium and its properties were universally known. During those days opium was chiefly produced in Asia Minor and its cultivation developed into a big industry. There also it attracted the attention of the nomadic Arab traders, who were responsible for spreading the knowledge concerning this drug, and for carrying it to the different countries in the East including India and China. They knew the secret of its dissipative effects and spread the drug habit to the remotest corners of Asia. It is borne out by the testimony of historical records that opium was unknown in China previous to A.D. 763 and there is evidence to show that it was introduced into the country in the thirteenth century. Early Chinese works mention that the Arabs exchanged poppy capsules for other forms of merchandise and the Chinese name 'Ya-pin' is evidently derived from the Arabic 'Af-yun'.

The history of the entry of opium into India is less definite than that of its entry into China. Some evidence has been adduced to show that opium was known in India in the latter half of the ninth century and it was undoubtedly widely known in the country in the fifteenth century. When the Portuguese first came to Cochin in 1498, opium was an article of trade taken from Arabia to Calicut and other places. By the end of the fifteenth century, they had actually started growing opium in India. According to Professor Bloomfield no word equivalent to opium occurs in Sanskrit literature. It may accordingly be concluded that opium was not an indigenous product of India. It is only since the time of the Mohammedan conquest that the word 'Khash-khash' (poppy seeds) or 'Khash-khasharasa' (a juice of the poppy) begins to appear in Sanskrit literature, and all the vernacular names in India (Sanskrit 'Ahiphena' and Hindi 'Afim') are traceable to the Arabic word 'Af-yun'. The English word 'Opium' also appears to have the same derivation. This conclusively shows that it was introduced by the Mohammedans.

OPIUM IN THE INDIGENOUS MEDICINE.—No reference has been made in the ancient books on Hindu medicine either to the poppy or its products. The exact time at which opium was introduced into the Ayurvedic medicine is difficult to determine. In the classic works of Chakradatta, Sushruta and Vagbhatta, no mention is found of opium. The last of these works is believed to have been written in the sixth century A.D. The author and the commentator who wrote Chakradatta in the eleventh century, does not mention opium in this work. It is, however, contended that in a work on toxicology written by Narayan of Malabar about A. D. 862 the use of opium in the treatment of rat poison has been mentioned. In the later work such as Sharangadhara (fourteenth century) and Bhavaprakash (sixteenth century) opium is freely mentioned and is used in several preparations. It is probable, therefore, that opium came to India along with or a little before the Mohammedan conquest. Opium is not used to a very great extent in the Ayurvedic medicine at the present time, its administration being mainly confined to two diseases namely diarrhoea and dysentery and that

only in certain stages. It is said to cure 'the concurrent derangement of the three humours, increase the seminal and muscular powers and produce stupefaction of the brain.' The curious fact is that the Hindu physicians appear not to have made use of the pain-relieving properties of opium.

In the Mohammedan medicine opium has been described as an anaesthetic and its pain-relieving properties were fully appreciated many centuries ago. It was prescribed in hemicrania, pain in the joints, lumbago, etc., and was not only given internally but was applied externally also in the form of a paint. It was also used in dysentery and diarrhoea. With regard to its action on the brain it was fully realised that it stimulates at first giving rise to a sense of pleasure and satisfaction, increase of physical vigour and a feeling of warmth; these properties give rise to habit formation. The narcotic properties of opium and its sedative action on the respiratory tract was fully appreciated and it was largely employed against severe cough, asthma and hiccough. The Mohammedan physicians also recommended it as an aphrodisiac, as it was believed to lengthen the time of seminal discharge during coitus. At the present time opium is used in combination with other drugs in the treatment of diabetes mellitus. The investigations of the senior author show that opium is prescribed in the indigenous medicine to a very limited extent. It is not, as is commonly believed, very freely used by Kavirajes and Hakims so as to lead common people to resort to it.

PRODUCTION OF OPIUM IN INDIA.—It is possible to grow the poppy in a temperate or subtropical climate where the rainfall is not excessive. The yield is smaller in the temperate than in the subtropical regions. The first recorded instance of the cultivation of the poppy in India in the fifteenth century mentions Cambay and Malwa as the places where it was grown. After its advent into this country, it appears to have been cultivated primarily along sea-coast areas and penetrated later into the interior of the peninsula. It was the white variety of poppy that was and even now is largely grown, although it yields the least amount of morphine, the purple variety giving the highest yield (nearly 3 times as much morphine as the white variety) and the red variety coming in an intermediate position. This is due to the fact that the former is best suited to the climate and can be grown in almost any part of the country. The purple variety, however, grows luxuriantly in Rajputana and Central India while the red-flowered variety with dark seeds is cultivated in the Himalayas.

So extensively was the poppy grown in the time of the Moghuls that opium became an important article of trade with China and other eastern countries. Malwa opium was characteristic of that part of the country. During the reign of the Emperor Akbar, its importance as a source of revenue was first appreciated and it was he who made opium a State monopoly. It is stated by Abul-fazl in *Ain-i-akbari* that poppy was cultivated in Fatehpur, Allahabad and Ghazipur. It was mainly grown in certain areas of Uttar Pradesh. It was not grown in Bihar at that time, but later that state produced large quantities and cultivation spread extensively to other parts of India. Roxburgh, Elliot and Ainslie make no mention of the cultivation of opium in South India, but it appears probable that the poppy was grown in that part of the country. There is no doubt that it was extensively cultivated during the Moghul rule, not only in Bengal but in Orissa also.

After the fall of the Moghul Empire, the state lost its hold on the monopoly and control over the production and sale of opium was appropriated by a ring of merchants in Patna. In 1757, the monopoly of the cultivation of the poppy passed into the hands of the East India Company who had by that time assumed the responsibility for the collection of revenues in Bengal and Bihar. When Warren Hastings was appointed Governor-General, he brought the whole of the opium trade under the control of the Government. Since then, though changes have been made in the methods of control of production, distribution, sale and possession of opium, the monopoly has been solely in the hands of the Government and a strict control has been exercised in the best interests of the people of the country as a whole. Under the East India Company and afterwards under the Crown, general cultivation of the poppy and the production of opium were prohibited; these being restricted to three centres: (1) Patna or Bengal opium, from poppy grown in Bihar and Bengal; (2) Benares opium, from the Uttar Pradesh; (3) Malwa opium produced in a large number of areas of Rajputana, Gwalior, Bhopal, Baroda, etc.

During recent years, cultivation of the poppy has been almost entirely limited to Uttar Pradesh. Permission to grow the plant is obtained by a written license and the whole of the product is purchased by the Government. A certain amount of opium was also grown in the Punjab chiefly for internal consumption of the state, but this has now been practically stopped. Poppy was also grown throughout the length and breadth of the Himalayas especially in the Simla Hills, but in small quantities mostly for local consumption. The production from this source is also being carefully watched. The result of restricting the cultivation of the poppy is that not only is less opium produced, but also the temptation is removed from the peasants' door and, therefore, addiction in rural areas has considerably decreased. This factor has also altered the form of indulgence. It is clear from the historical records that a beverage made from poppy capsules and the plant under the name of 'post' or 'kuknar' was extensively indulged in the days of the Moghuls and later, throughout the whole country. This has now become practically extinct.

DECREASE OF POPPY CULTIVATION.—That the cultivation of poppy has enormously decreased during recent years can be proved by statistics which are now available. According to the figures collected by Watt in 1881, the total area under poppy cultivation in British India did not exceed 10,00,000 acres, and he estimated that it had been stationary for 30 years previously. The average yield per acre was about 15 to 20 lb. of opium and it was calculated that roughly not more than 2,00,00,000 lb. of opium were produced. The Major part of this was intended for export, a comparatively small quantity being kept for consumption at home. Since that time there has been a progressive decrease which has been especially marked during the last few decades.

It will be seen from the following statements that during the last few decades the cultivation of poppy and the production of opium have fallen to less than half of what it was in 1920:

				Area Under Poppy Cultivation 536,282 Acres	Opium Produced
1881	—	—	—	536,282 Acres	7,800,521 lb.
1920	—	—	—	154,621 "	1,870,436 "
1921	—	—	—	116,055 "	1,179,977 "
1922	—	—	—	117,932 "	1,518,828 "
1927	—	—	—	52,279 "	885,641 "

Both the export and the internal consumption of opium have decreased. A glance at the export returns will show that these have fallen very considerably. While in 1900-01, 69,708 chests were exported, in 1919-20 the number dropped to 10,509 chests and, in later years, it has been still further reduced. (Export chest contains 160 lb.). According to the latest reports the area put under poppy cultivation during the opium year 1952-53 (i.e., from 1st Oct., 1952 to 30th Sept., 1953), was 83,626 acres. This area is only an insignificant fraction, no more than 1/5000 of the cultivable in the country. In selecting the areas for cultivation of poppy the Excise Department of the Government of India, consult the State Governments as the cultivation, collection and production and sale of poppy and opium falls within the purview of the Central Excise Department.

According to the statistics the following amounts of raw opium were reported as produced during the years 1948-52 by different countries in the world. This information as prescribed by the 1925 Government Convention has been supplied to Permanent Central Opium Board.*

Country	1948 Tons	1949 Tons	1950 Tons	1951 Tons	1952 Tons
Turkey	380.2	10.4	184.8	357.8	463.6
India	342.2	220.0	230.7	526.7	349.7
Iran	21.3	199.7	480.9	32.2	130.6
U. S. S. R.	75.0	76.0	85.7	93.8	104.3
Yugoslavia	21.5	0.5	19.2	22.0	12.1
Bulgaria	4.4	0.7	1.0	0.9	6.7
Other countries	0.1	—	0.5	—	—
TOTAL :	844.4	507.3	1,002.8	1,033.4	1,067.0

*Report to the Economic and Social Council on Statistics of Narcotics for 1952 and the work of the Board in 1953. United Nations, Geneva, 1953.

CHEMICAL COMPOSITION.—Opium varies considerably in appearance, composition and quality according to its place of origin and the mode of its manufacture. It is grown in many parts of the world and chiefly in Turkey, Asia Minor, Persia, India, China, Egypt and south eastern Europe. In addition to some 25 alkaloids present in opium (mentioned below) it contains acetic, lactic, sulphuric and meconic acids, gummy and pectinous substances, albumin, wax, fat, caoutchouc, resin, and several indifferent bodies, viz., meconin, meconoisin.

The number of alkaloids so far identified and their proportions in opium are as follows :

* Morphine	9	per cent.	Laudanosine	0.0008	per cent.
* Codeine	0.3	" "	Lanthopine	0.006	" "
Neopine			Cryptopine	0.08	" "
* Thebaine	0.4	" "	Papaveramine		
Porphyroxine			* Narcotine	5	" "
Meconidine			Gnoscopine	0.2	" "
* Papaverin	0.8	" "	Pseudomorphine	0.02	" "
Pseudopapaverine			Tritopine	0.0015	" "
Codamine	0.002	" "	Hydrocotarnine		
* Laudamine	0.01	" "			

*Those marked with asterisks are important.

The following statements summarise some of the facts about the chief opium alkaloids:

Alkaloid	Formula	Discoverer	Date	Properties
Morphine	$C_{17}H_{19}O_3N$	Sertürner	1806	Strong bases, which are
Codeine	$C_{18}H_{21}O_5N$	Robiquet	1832	alkaline to litmus, highly
Thebaine	$C_{16}H_{21}O_3N$	Pelletier	1835	toxic.
Narcotine	$C_{22}H_{23}O_7N$	Derosne	1803	Feeble bases, which are
Narceine	$C_{23}H_{27}O_8N$	Pelletier	1832	but slightly toxic.
Papaverine	$C_{20}H_{21}O_4N$	Merck	1848	

The opium alkaloids are divided into two groups: (1) the phenan-threne-pyridine group comprising morphine, codeine, pseudomorphine, neopine and thebaine, (2) the benzyl-isquinoline group consisting of papaverine, narcotine and most of the remaining alkaloids. The members of the first group are strong bases and very poisonous whilst the second group as a whole have little physiological action. The valuation of opium depends on the amount of morphine present in the sample—this being the most abundant and physiologically the most active of the alkaloids. The amount of morphine present in samples of opium from different countries is as follows:

Turkey 5—14 per cent.; Persia 6—14 per cent.; Egypt 0.28—8 per cent.; India 3—15 per cent.; China 1.5—11 per cent.; Japan 0.7—13 per cent.; Bohemia 11—12 per cent.; Turkestan 5—18 per cent.; Australia 4—11 per cent.

The general alkaloidal composition of opium may be judged from the following figures given by Dunncliff (1937) for Indian opium: Morphine 8 to 20 per cent.; Narcotine 5 to 7 per cent.; Codeine 1 to 4 per cent.; Papaverine 0.4 to 1.0 per cent.; Narceine 0.5 to 1.0 per cent.

Opiums of different countries differ from one another not only in morphine-content and moisture-content but in the relative proportions of the different alkaloids. Indian opium, for example is particularly rich in codeine. Typical analyses are as follows:

Variety	Moisture, per cent.	Anhydrous Morphine per-cent.	Codeine per cent.
Turkish, Old Style	13.1—19.7	10.7—11.3	—
Turkish Govt. Monopoly	14.9—16.6	12.5—13.0	0.5—2.0
Yugoslavian	8.9—11.5	16.7—17.1	1.0
Indian	11.1—12.9	9.6—10.5	4—5
Persian (Red paper)	—	10.09	2.0—3.7
Persian (Poppy leaf)	9.6—12.0	12.2—13.2	—

The Indian opium exported into England is in the form of square blocks weighing about 2 lb. each. Each is wrapped in two coats of white paper, which show oily stains produced from the opium. It is tied with string and is exported in cases containing about 80 cubes. It has a moisture content of about 11 to 13 per cent. and a morphine content of about 10 per cent. Indian opium is very difficult to dry and powder on account of its oily nature. It is therefore not used for preparation of powdered opium but is mainly employed for the manufacture of alkaloids.

Formerly it was believed that Indian opium, which was chiefly used for smoking purposes, had the smallest quantity of morphine and hence was unsuitable for medicinal purposes. Since 1914 special efforts have been made to produce in India opium suitable for medicinal purposes and the morphine content of the Indian drug has risen steadily. Indian opium can now compete with the best Turkish opium as regards its medicinal value. It has further the advantage of being richer in codeine than opium produced in other countries. The relative proportions of the important bases in the Indian and Turkish opium are stated as follows:

	Indian Opium (average)	Turkish Opium (average)
Morphine	..... 9.5—14.2 per cent.	10—14 per cent.
Codeine	..... 1.8—4 " "	0.2—3.2 " "
Narcotine	..... 3.9—7.6 " "	4—11 " "

The control over the production of opium in India is very effective. From the very early days, the Government have realised that the availability of a drug in a locality determines the nature and the prevalence of addiction in that area. The necessity of restricting cultivation of the poppy to cut down opium consumption was fully appreciated by the authorities. The Governor-General, Lord Ripon, in a despatch to the Secretary of State many years ago, pointed out that unrestricted cultivation of poppy would stimulate the opium habit among the population. The cultivation of poppy was controlled as early as 1857 when a law was enacted to regulate opium production. Poppy cultivation is even now regulated by Act XIII of 1857 (as amended by Act I of 1911) and by Act I of 1878. Under these Acts the cultivation of poppy within India is permissible only under license; the total area to be sown is fixed by the Government from year to year, and the license specifies the exact amount which the licensee may cultivate. With the exception of certain hill tracts in the Punjab, where the people were allowed to grow poppy to a small extent and to sell the opium direct under Government control to licensed vendors, the cultivator is bound to sell the whole of his produce to the Government at a fixed rate. The cultivation in the Ajmer-Marwara has been prohibited since January, 1927; and it is now confined to a limited area in the Uttar Pradesh.

The seed is sown in October and November. In December, the Opium Officers check and record the area under seed. The juice of the poppy is collected from January to March and is delivered from April to June. The whole of the juice extracted from the poppy must be delivered to the Government officers.

With regard to the distribution of opium, the internal policy of the British Government of India was one of non-interference with the moderate use of raw opium whether the object of the consumer be some real or supposed physical benefit, or merely the indulgence of the almost universal desire of human beings (particularly those whose occupations involve exposure or severe bodily exertion) for a stimulant or narcotic. It is, and always has been, the desire of the Government to suppress excessive indulgence. The manufacture, possession, transport, import, export and sale of opium are strictly controlled under the Opium Act of 1878. An individual can obtain opium only from a licensed vendor or a licensed druggist. Each stage of distribution down to the retail vendor is safeguarded by an elaborate system of transport passes, while the conditions designed to restrict abuse of the license on the part of a retail vendor are most stringent. He may not sell to any one person at one time more than the quantity of opium that an individual may lawfully possess; he may sell only for cash and only on the premises for which he is licensed; he must not allow consumption on such premises and he must keep correct daily accounts of his sales, which are open to inspection by Excise Officers at all times. With regard to exports, the Government of India, as a result of an agreement concluded with the Chinese Government, began in 1908 to diminish progressively the total amount of opium sold in Calcutta for export; and since 1913 they have resolutely maintained the prohibition of export of opium to China. One of the provisions of the Hague Convention of 1912, *viz.*, that raw opium shall not be exported to countries that prohibit its import, has always been strictly observed by the Government of India, and since 1915 it has also been their policy to enter into direct sale agreements with the Governments of the imposing countries who are responsible (as signatories to the Hague Convention) for limiting imports to 'legitimate' requirements and for preventing export. With effect from January 1923, the 'Import Certificate System' prescribed by the League of Nations, has also been adopted. In 1926, the Government of India initiated a new export policy. With effect from April 7th, 1926, the public auctions at Calcutta were discontinued, and from that date no opium could be exported to the Far East except under a direct agreement with the

Government of the importing country. Further, the Government decided to abolish exports to the Far East and no opium was exported for purposes other than medical and scientific after December 31st, 1935.

As regards the consumption of opium in India for euphoric purposes, there is no doubt that opium is habitually taken by certain sections of the population. It is consumed in the form of a pill or in solution in water. Opium smoking, except in Assam and Central Provinces, is a very uncommon method of indulgence nowadays. The opium habit, however, is not nearly so common in India at the present time as might be imagined from some recent publications on the subject. The habit is not widely disseminated among the populations, and although there are admittedly certain areas and certain classes of populations which are badly affected, these constitute a small minority. There is evidence to show that in most parts of India the consumption is well below the standard laid down by the League of Nations as being necessary for purely medical and scientific needs of the population. Here and there in every province there are areas where consumption of opium is very high. Those zones are being carefully investigated by the Local Governments concerned to determine the causes which have led to increased consumption of opium with a view to their eradication. The habit is not spreading, and in fact during the last twenty years it has shown a remarkable decrease all over the country. This is shown by the following figures giving the quantity of excise opium issued for consumption in British India including Burma:

1911-12	...	...	...	....	1,031,227 lb.
1919-20	...	...	...	....	885,721 „
1925-26	...	...	...	....	600,784 „

The decrease has been more marked lately and the work of the senior author shows that the factors which have been instrumental in reducing consumption are decrease in its production and increase in its price. For further information on the subject of opium habit and its effects the reader is referred to the original papers written by the author and his co-workers.

EFFECTS OF OPIUM ON BLOOD-SUGAR AND ALBUMINURIA.—The effects of opium on blood-sugar of diabetics and non-diabetics have been worked out by Chopra and Bose (1931) in view of the popular belief that this drug has got beneficial effects in glycosuria. It has been shown that small and moderately large doses of opium have little or no effect on the blood-sugar. Another popular belief among the medical profession is that patients suffering from kidney diseases stand opium badly. The same workers have shown that opium in doses ranging from 1 to 9 gr. daily in patients suffering from albuminuria has no deleterious effect on the quantity of albumin excreted; in fact in many cases there is an appreciable decrease.

PSYCHOLOGICAL EFFECTS OF OPIUM ADDICTION.—Chopra and Bose (1931) have carefully studied the psychological aspects of opium addiction on a series of patients in the hospital. These workers have shown that in the withdrawal or abstinence symptoms, there is a predominant psychic element which can be over-

come if the circumstances demand it. This is amply shown by experience with convicts in jails, and in men under war conditions, who have to give up opium suddenly and yet suffer no marked discomfort or withdrawal symptoms. During the treatment of addicts to rid them of the opium habit, opium can be largely or totally replaced by substances like gentian or nux vomica preparations in pill form without trouble. The series of cases studied by these workers show that if the patient is not aware that he is taking opium, the drug can be effectively given for weeks and months for its therapeutic effects and can be stopped at any moment without producing abstinence symptoms. Physicians, therefore, need not hesitate to use opiates in special cases where these are indicated, provided the identity of the drug is concealed from the patient.

NARCOTINE.—Narcotine is one of the alkaloids occurring in opium which, so far as its quantity is concerned, comes next to morphine in importance. In many varieties of opium it is quite half as abundant. Although it was isolated about the same time as morphine, it does not appear to have received much attention at the hands of the early workers possibly because of its less powerful action. It was considered by its discoverer Derosne to be the active principle of opium and this fact accounts for its name *narcotine*. Later it was suggested that *anarcotine* would be a more fitting name because it lacked narcotic effects. It would appear that the older writers had appreciated the absence of any marked narcotic properties in this alkaloid as, except for occasional reference to its use in the treatment of migraine as an analgesic, it has not figured anywhere in therapeutics for its action on the central nervous system. The only other use made of it in medicine was in the treatment of malaria.

CHEMISTRY AND PHYSICAL PROPERTIES.—Narcotine, $C_{22}H_{23}O_7N$, exists in the plant in a free state. It has been found to occur in the dried poppy capsules in fairly large quantities. An analysis of unlanced poppy heads showed that it constituted about 30 per cent. of the total alkaloidal yield. It usually occurs to the extent of 5 to 6 per cent. in Asia Minor opium, but in Indian and Persian opium it is present to the extent of 10 to 12 per cent. A perusal of the following figures will show that in Patna or Bihar opium the narcotine content is nearly double that of the morphine content; in Malwa opium narcotine is slightly larger in quantity than morphine; in Smyrna opium narcotine occurs in much smaller quantities, less than $\frac{1}{2}$ of the morphine content.

Description of Opium		Morphine per cent.	Narcotine per cent.
Patna Opium (Bihar Provision cake)	.....	3.98	6.36
Malwa Opium	.....	4.61	5.14
Smyrna Opium	.....	8.27	1.94

Narcotine is present in opium in a free state though some authorities think it occurs in the form of a meconate. It can be readily separated from the other alkaloids.

When opium is extracted with water, morphine goes into solution, but the greater part of narcotine remains undissolved. By exhausting the residue with dilute hydrochloric acid the alkaloid is removed as a hydrochloride; from the solution of this salt the base may be precipitated by sodium bicarbonate and crystallised from alcohol. Narcotine may also be extracted from opium by boiling it with ether.

Narcotine occurs as odourless, tasteless, shining prismatic crystals, having a melting point 176°C . The base is very slightly soluble in water, 1 in 25,000 at 15°C and 1 in 7,000 at 100°C . It is soluble in alcohol, ether and in benzene; very soluble in chloroform; slightly soluble in amyl alcohol or light petroleum.

PHARMACOLOGICAL ACTION.—Narcotine is an important subsidiary alkaloid of opium in as much as it constitutes on an average 5 to 6 per cent. of opium. It occurs in large quantities as a bye-product in the manufacture of morphine and codeine and so far little or no use has been made of it in medicine. The alkaloid is readily absorbed from the site of injection; it does not produce much local irritation or necrosis of the tissues. Narcotine definitely inhibits the peristaltic movements of the gut. It relaxes the tone of the involuntary muscle tissue all over the body, e.g., of uterus, bladder, gall bladder, etc., by its direct action on the muscle fibres.

Given intravenously in animals, narcotine produces a fall of systemic blood pressure followed by a slight rise. The fall is due to dilatation of the blood vessels, especially those of the splanchnic area, by its direct action on the musculature of the vessel wall. The subsequent rise is probably due to reflex stimulation of the vasomotor centre to counteract the fall in systemic pressure. The stimulation of the auricle and ventricle seen in myocardiograph experiments cannot be wholly explained by vasomotor stimulation, and there is evidence to show that the sympathetic ganglion cells of the cardiac plexuses may be excited. The depression of heart seen in perfusion experiments is more than compensated by these two factors. Narcotine, unlike morphine, stimulates the respiratory centre in the medulla. The plain muscle of the bronchioles is relaxed. The drug, in the animals at any rate, has a stronger action on the cord than on the brain. It undoubtedly enhances the action of morphine and codeine so that much smaller quantities of these alkaloids would be effective if given in combination with narcotine. The voluntary muscles are not affected. The secretions do not appear to be greatly influenced by narcotine in therapeutic doses. In toxic doses there is a marked stimulation of salivary secretion, but urine, sweat, etc., are hardly touched. Narcotine is not a very toxic alkaloid; its minimum lethal dose is 2 mg. per gm. body weight in frogs and 1.5 to 2.0 gm. per kilo body weight in cats. Large doses such as 1 or 2 gm. can be given in man without producing any marked toxic effects.

THERAPEUTIC USES.—In the report of the Opium Commission of 1895, it was stated that the habit of taking opium prevails in excess among the population of low-lying, damp and malarious districts of India, and it was implied that this drug has an anti-malarial action. Dr. Roberts in his note said that the belief in the usefulness of opium in the complaints of damp and malarious districts was very widely spread. According to him the consumption of opium in the marshy districts of England was very large in the days when lands were undrained and malaria was prevalent. The evidence laid before the Opium Commission showed that in some districts of India the local consumption of opium bore a close relation-ship to the greater or less prevalence of malaria in these localities.

OPIUM IN MALARIA.—So far as the action of opium in malaria is concerned, it has been shown by the senior author (1928) that this drug is not much used at the present time, as a household remedy for its supposed prophylactic or curative effects. In some of the low-lying districts of the Punjab along the course of such rivers as the Jhelum, the Chenab and the Indus, the climate is very damp and a virulent type of malaria prevails. The spleen index in these areas is also very high but the consumption of opium is very small indeed, while in some of the comparatively dry and healthier areas the consumption is enormous. Careful inquiries in these areas did not show the existence of any belief among the rural or urban population in the anti-malarial properties of opium in combating an

attack or in preventing recurrences. There is no doubt that the main factor responsible for the extent to which the drug was used was the availability of opium in a particular locality. When opium was grown in these very areas, its consumption was much greater than it is at the present time. Opium on account of its sedative effects undoubtedly ameliorates the symptoms produced by malaria, but it has no curative action whatsoever in this disease. Our everyday experience among opium addicts in the central districts of the Punjab convinced us that they suffered just as much from malaria as those who were not addicted to the drug, during the seasons when this disease was prevalent. Opium has neither a prophylactic nor a curative action in the disease.

NARCOTINE IN MALARIA.—As regards the suggestion that narcotine may possibly be the alkaloid which has anti-malarial properties, this belief appears to have been based on two communications. The first one was from Dr. Palmer (1857-59) who at Ghazipur treated 546 cases of malaria with narcotine, in doses ranging from 1 to 3 gr. corresponding to 15 to 48 gr. of opium. He summed up his experiences by saying that in 70 per cent. of cases the fever was permanently arrested at the second paroxysm after narcotine was administered, in 20 per cent. the arrest was equally sure, but was not quite so quick and in 10 per cent. the medicine did not appear to have any curative results. The second communication is a report by Dr. Gordon which was published in the seventh volume of the *Indian Annals of Medical Science*. This worker treated altogether 684 cases of malaria with narcotine and gave details of 194 cases. According to him 187 were rapidly cured and only in 7 cases the alkaloid failed to produce any effect. Moreover, he asserted that narcotine cured some cases in whom quinine had failed. After this work narcotine continued to be in large demand and was regularly supplied from the Government factories.

As the effect produced by narcotine in malarial fever still remained undecided the senior author tried the action of this alkaloid in a series of cases with a view to determine if it really produced any effect on the malarial parasites or on the clinical symptoms occurring in the disease. The alkaloid narcotine even in such large doses as 10 to 15 gr. daily has no effect on the parasites of any forms of malaria circulating in the peripheral blood. The temperature of the patient remains unaffected and rigors and paroxysms continue. The algæic areas, however, appeared to be somewhat depressed and sensibility of the patient to pain and discomfort produced by disease was decidedly diminished. The patients looked more comfortable after the alkaloid was administered and felt better although the temperature was not appreciably affected. There was no very marked stimulation of the respiration and the heart, and no heightening of the reflexes, so that in therapeutic doses in man at any rate there were no outward signs of hyper-excitability of the medulla or the spinal cord.

ECONOMIC ASPECTS.—A perusal of what has been said will show that narcotine occurs in large quantities in the Indian opium and that if it could be utilised in therapeutics, it would be available at a very cheap price. Large quantities of this alkaloid had accumulated in the Opium Factory at Ghazipur since its use was abandoned in the treatment of malaria. As the alkaloid itself does not appear to have any potent therapeutic properties, attempts have been made to prepare derivatives from it which might be physiologically more active. One of these products is Cotarnine hydrochloride (Stypticin). Cotarnine hydrochloride was

placed on the market many years ago, and it is said to be useful in all forms of uterine haemorrhages and also for checking profuse menstruation; 1 to 2 per cent. may be used as a tampon. The alkaloids of opium are more or less narcotic and convulsant in their action, but as the latter group occur in small quantities, their action is dominated by the former group. The exact difference between the action of morphine, opium and combination of other alkaloids introduced in therapeutics under the names of 'pantopon', 'narcophine', etc., have not been worked out. It is, however, well-known that narcotine which is not a very active alkaloid increases the toxicity of morphine and codeine. Older investigators have shown that a dose of opium acts more strongly on the frog than the corresponding quantity of morphine contained in it. Small doses of morphine, in themselves inactive, produce when combined with small quantities of the subsidiary alkaloids, severe symptoms of poisoning (Gottlieb and Eeckhout, 1908).

Winternitz (1912) showed that hypnotic and sedative effects were produced in man by alkaloids of opium from which morphine had been completely eliminated. The only alkaloid barring morphine that has a sedative effect in man is codeine which when given by itself has a feeble action. In combination with the other alkaloids of opium, however, codeine produces as strong an effect as morphine. The other alkaloids, therefore, appear to potentiate the action of codeine and of these narcotine has been shown to be the most important synergist. Narcotine also has a well-marked synergistic action when combined with morphine so far as its action on the central nervous system is concerned. Levy (1916) found that 3 mg. of an equal mixture of morphine and narcotine exerted as great a narcotic action as 10 mg. of morphine. The greatest increase in activity is obtained when equal parts of narcotine and morphine are given together. The decrease in perception of pain in man is also more marked when morphine and narcotine are combined. The combination of one molecule of each with meconic acid has been recommended by Straub (1912) and named 'narcophine' for use as a general analgesic. Interesting experiments were conducted by Macht, Johnson and Bollinger (1916) and Macht, Herman and Levy (1918) to show that the increase in the pain depressing action is due to the subsidiary alkaloids especially narcotine. By measuring the strength of the induced current which would just produce a pain sensation from a single sensation point, they showed that 'pantopon' and 'narcophine' increase the threshold value of the effective stimulus more than the corresponding amount of morphine. These observations have been confirmed and open a wide field for the use of narcotine.

We have already referred to the depressing effect of narcotine on the algesic areas in the brain, and from experience with this alkaloid we can fully corroborate the synergism which exists between narcotine and morphine, and narcotine and codeine. Narcotine also possesses an antagonistic action to the depressing effect produced by morphine on the respiratory centre. It appears therefore that, although narcotine by itself is not a therapeutically very active drug, it has got possibilities of being a useful therapeutic agent by combination with other opium alkaloids in suitable proportions which have yet to be worked out.

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PEUCEDANUM GRAVEOLENS Linn. (Umbelliferæ)Syn. **Anethum sowa** Kurz

INDIAN DILL

VERN.—Beng.—*Sowa*; Bomb.—*Suva*; Guj.—*Surva*; Hind.—*Sowa*; Kash.—*Soi*; Kum.—*Soya*; Mar.—*Shepu*; Punj.—*Soya*; Sans.—*Satapushpi*; Tam.—*Sata kuppi*; Tel.—*Sompa*; Urdu.—*Soya*.

The properties of dill oil, dill water and the other preparations in which the fruit of this plant is administered, are too well-known to require a detailed description. Apart from its medical use it is in great demand as a condiment, and the oil derived from it is largely used in the manufacture of soap.

Anethum sowa is found throughout India and is often cultivated as a cold weather crop. It is indigenous to the countries bordering the Mediterranean sea, but is also cultivated in the South of France, Saxony and Russia. This herb differs from the European true dill in having its fruits longer (twice as long as broad) and more strongly convex as well as by the paler colour of dorsal ridges, which render them more conspicuous than those of the true dill. The essential oils derived from Indian and foreign fruits also differ in composition.

The sowa fruits from Bangalore market have been examined by Rao, Sudborough, and Watson, who report a yield of 3.19 per cent. of an essential oil. This oil consists of two fractions, the one constituting 32 per cent. of the total being heavier than water and the other 68 per cent. being lighter than water. The entire oil has sp. gr. at 15°, 0.9785; opt. rot. at 25°, +47.6°; n_D^{25} , 1.4943; and solubility in 3 volumes of 80 per cent. alcohol. It contains 19.5 per cent. of carvone.

Malaviya and Dutt obtained from the fruits 0.474 per cent. and 0.825 per cent. of heavier and lighter than water fractions of essential oil, respectively, having the following characteristics; sp. gr. at 20°, 1.0573 and 0.9719; opt. rot. at 30°, +23.6° and +38.5°; and n_D^{20} , 1.5385 and 1.4905. The oil contained d-limonene (9 per cent.), d-carvone (46.5 per cent.), dill-apiol (39.6 per cent.) and probably traces of anethole, anisaldehyde, eugenol and thymol.

According to Parry, the Indian sowa fruit oil usually has, sp. gr., 0.945 to 0.970 and 0.918; and opt. rot. +40° to +50°, as against the European dill oil

which has sp. gr., 0.895 to 0.918; and opt. rot. $+70^{\circ}$ to $+82^{\circ}$. This high sp. gr. of the sowa oil is said to be due to the presence of a large amount of dill-apiol. If this were removed, the physical characteristics of the Indian oil are said to approximate those of the European oil. Thus, according to Rao, Sudborough and Watson, Baroda Sowa oil from which apiol fraction had been removed had sp. gr. at 15° , 0.9030; opt. rot. at 25° , $+63.6$; and n_D^{25} , 1.4792; contained 18 per cent. of carvone.

It will thus be seen that, although sowa fruits have often been confused with the European dill, they yield an oil with a higher specific gravity, lower amount of carvone and with other differences. It does not, therefore, appear correct to use them in medicine as a substitute for the European dill. The Japanese fruits are said to be identical with the Indian Sowa fruits. According to Branigan, American market has been importing for many years sowa fruit oil, presumably for flavouring purposes, but Krishna and Badhwar could not confirm this statement.

The dried exhausted fruits contain 16.8 per cent. of fat and 15.1 per cent. of proteins, and have been recommended as a cattle feed. The sowa herb yields 0.06 per cent. of an essential oil, which has a high proportion of terpenes (x-phellandrene) but no carvone. The European and American dill herb oils contain both carvone and d-x-phellandrene, although the carvone content (about 20 per cent.) is much lower than that of the seed oil. According to Indian Pharmaceutical Codex the constituents of Indian dill fruit yields 3-3.5 per cent. of volatile oil. The volatile oil yields dill-apiole, $C_{12}H_{14}O_4$, an oily non-crystallisable liquid, isomeric with parsley apiole. Other constituents are a fluid hydro-carbon anethene, $C_{10}H_{16}$, and another substance identical with carvone.

The Essential oil Advisory Committee of the Council of Scientific and Industrial Research, report (1946) that Dill seeds exported from India in 1937-38 and 1938-39 amounted to Rs. 55,097 (237 tons) and Rs. 73,488 (355 tons) respectively.

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PICRASMA QUASSIOIDES Benn. (Simarubaceæ)

QUASSIA WOOD

This is a tall scrambling shrub generally found in the outer Himalayas from Chenab eastwards between 3,000-8,000 ft., Chamba, Kulu, Bashahr, North Garhwal between 6000-8000 ft., Nepal and Bhutan. Also in the Khasi and Naga Hills in Assam at altitudes of 3,000-8,000 ft. It is also found in China. The plant flowers in April-June. The bark and the leaves are used in the Punjab as a

febrifuge and as an insecticide. The general structure of the wood as well as the taste of *P.quassioides* closely resemble that of *Picræna* or *P.excelsa* of the British Pharmacopoeia and it has been recommended as a substitute for it. Official quassia is the stem wood of *Picræna excelsa* (Sw.) Lindl. (*P.excelsa* (Sw.) Planchon), which is known in commerce as Jamaica quassia. This wood is also used in America, but most continental pharmacopoeias prefer to include the wood of *Quassia amara* Linn., which is known as Surinam quassia. *Picræna excelsa* is a tree 15 to 20 m. high which grows in the West Indies (Jamaica, Guadeloupe, Martinique, Barbadoes, and St. Vincent). *Quassia amara* is a shrub 1 to 2 m. high which grows in the Guianas, northern Brazil, and Venezuela. Experimental work carried out at the Calcutta School of Tropical Medicine show that *P.quassioides* contains a bitter principle *quassin* which is almost identical with the *picasmin* of the official *P. excelsa*. An allied species, *P.nepalensis*, was also examined but was found to be inactive.

So far no standard chemical methods for the isolation of the active principles of this drug have been worked out. Quassin, a crystallisable bitter substance obtainable from the drug, is supposed to be the active principle but there are other bitters associated with it. As there is no accurate method of estimation of quassin, it is difficult to assess the value of the Indian drug in terms of the drug in use in the B. P. Following the method suggested for the isolation of the active principles of *P.excelsa* in the British Pharmacopoeia, the results obtained were as follows:

		<i>P.quassioides</i>	<i>P.excelsa</i>
Aqueous extract	.....	8.36 per cent.	3.04 per cent.
Alcoholic extract	.....	5.78 " "	3.25 " "
Bitter principles	.....	0.31 " "	0.48 " "

The bitter principle was obtained by repeated treatment of the alcoholic extract with hot water, neutralising, concentrating the solution and finally precipitating with tannic acid. The precipitate thus produced was decomposed with freshly precipitated lead hydroxide, evaporated to dryness and extracted with absolute alcohol. The alcoholic solution was evaporated on a water bath and the residue then weighed. White needle-shaped crystals were obtained mixed with other extractives and the residue was extremely bitter.

The quantity of crystals which appeared in the case of *P.excelsa* was somewhat in excess of those derived from *P.quassioides*. Besides these, the latter contains a bitter alkaloid to the extent of about 0.05 per cent. and another fluorescing bitter substance soluble in chloroform amounting to 0.15 per cent. These act as adjuvants to quassin and enhance the action of the drug. The bitter principles named *picasmin* by Massute (1890) were shown by Clark (1938) to be single substance quassin, having two methoxy groups and the molecular formula $C_{20}H_{80}O_6$ (m.p. $205^{\circ}-6^{\circ}$). Tannin is absent. The Surinam drug *Quassia amara* Linn. contains in addition to quassin a related substance which Clark names *neoquassin* (m.p. $225^{\circ}-26^{\circ}$).

Quassia is a popular bitter and is largely used in the Western medicine. In the indigenous medicine, like many other bitter drugs, it is used as a febrifuge and as an antimalarial remedy. Though the official source, *P.excelsa*, is not available in India, *P.quassioides* is obtainable in large quantities. Apart from its natural habitat in the Himalayas, it has been found to be growing profusely at Mao, on

the border line of the Manipur and Naga Hills (Assam) at an altitude of 6,000 ft. The hills are accessible and transport facilities for the crude drug are said to be quite good. Gathercoal and Wirth (1936) reported that the wood of *Picræna quassioides* quite closely resembles *Jamaica quassia* (Official) in general appearance, microscopic structure and chemical constituents. This drug is official in the Indian Pharmacopoeial List, 1946 and Indian Pharmaceutical Codex, 1952.

Quassia is one of the most powerful bitters useful in loss of appetite due to gastric debility, but in over doses it irritates the stomach to produce vomiting. On account of its freedom from tannin it may be given with salts of iron. For the expulsion of thread worms an infusion (1 in 20) is used as an enema. Extracts of quassia are used as insecticides in horticulture.

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• **PIMPINELLA ANISUM Linn. (Umbelliferæ)**

ANISEED, ANISE FRUIT

VERN.—Beng.—*Mauri*; Bomb.—*Sonf*; Guj.—*Sowa*, *Anisa*; Hind.—*Saonf*, *Saurif*; Kan.—*Sampu*; Punj.—*Sounf*; Sans.—*Shetapushpa*; Tam.—*Sombu*, *Perunshiragam*; Tel.—*Kuppi*, *Sopu*.

P.anisum is an annual herb found originally in Egypt and the Levant but is now cultivated on the continent of Europe, chiefly in Russia and also in Spain, Holland, Bulgaria, France, Turkey, Cyprus and many other places. In Russia, a great deal of attention is paid to its cultivation and it is understood that the cultivation is gradually extending from the district of Valuiki to several other districts. The fruits as well as the essential oil distilled from them form a good source of revenue to the Russian producers. In Cyprus also, a good deal of anise is produced. In India, anise is found in various parts of the Uttar Pradesh and the Punjab and to a smaller extent in Orissa. It is not a true native of the Indian soil but is supposed to have been introduced by the Mohammedan invaders from Persia. It is, however, completely naturalised in India at present. But the major portion of the Indian demand is, however, met with by imports from Iran.

CULTIVATION.—The plant prefers a fertile or moderately rich, light, well-drained loamy soil. Since the seedlings are affected unfavourably by transplanting, the fruits are sown directly in the field. When the seedlings are 2 or 3 in. high, they are thinned out so as to be about 8 in. apart in a row. The rows are 1 ft. apart. About 12 lb. of the fruit are sufficient for planting an acre of land. In some countries the fruit is sown broadcast, but this presents a major difficulty in keeping the crop clean of weeds. The harvest is collected as soon as the tips of the fruits assume greyish-green colour. For this purpose, the plants

are cut and stocked in heaps. Often hand-pulling is preferred to cutting, the plants being piled, tops inward, in stacks about 6 ft. high, or the plants may be moved and at once built up into stacks of the same height. The fruits ripen in 4 or 5 days and then threshed out, cleaned and bagged for the market. Under favourable conditions a yield of 600 to 1,000 lb. per acre may be expected.

The fruit (known as aniseed) is one of the oldest spices and is used for flavouring cakes, curries, pastry, candy, and biscuits. It is also in demand by manufacturers of food for domestic animals. In medicine it is esteemed for its carminative and mildly expectorant properties, which are due to the presence of an essential oil. The essential oil from the fruit is used in medicine, perfumery, and for flavouring beverages and liqueurs. The distillation water of anise is sold in Indian bazaars as 'araq badian' or 'araq saunf', which is medicinal.

YIELD OF OIL.—The aniseed yields 2 to 3.5 per cent. of a colourless or pale-yellow essential oil which resembles that from star anise (*Illicium verum* Hook. f). The yield in some cases is higher, e.g., the Syrian fruits yield as much as even 6 per cent. of the oil. Although oils from both these plants are recognised by B. P., the one from star anise is the chief commercial product. For liqueur manufacture, however, a distinction is made between the two, since the oil from true aniseed is rather more delicate in odour.

CONSTITUENTS.—The oil contains 80 to 90 per cent. or even more of anethole to which it largely owes its characteristic odour and sweet aromatic taste. With regard to the other constituents, there has been some confusion in the literature, since sometimes the results of investigations carried out with star anise oil are ascribed to the true anise oil. However, according to Guenther (1950, *Essential Oils*, 4, 563), the true aniseed oil contains, besides anethole, methylchavicol and p-methoxy-phenylacetone (anisylacetone, anise ketone); the first fractions contain acetaldehyde, some sulphur containing compounds of a disagreeable odour, and perhaps, very small quantities of terpenes. According to *Pharmaceutical Codex* (1949, 567), it also contains anisaldehyde and anisic acid.

Anise oil is employed in medicine as an aromatic carminative to relieve flatulence. Being a mild expectorant, it is used as an ingredient of beverages and liqueurs, such as in the liqueur anisette. It has a limited use in perfumery, but is a popular flavour for dental preparations and mouth washes. It is widely used in the flavouring of culinary preparations and confectioneries. Anise oil is frequently adulterated with the lower-priced star anise oil, which according to B. P., is also considered oil of anise. From point of view of flavouring, anise oil from *P. anisum* is undoubtedly superior to that from *Illicium verum* (star anise). Other adulterants are fennel oil, turpentine oil, cedarwood oil, copaiba and gurjun balsam oils, etc. Almost all of these can be detected by their physical and chemical characters. Adulteration with synthetic anethole made from pine oil has also been reported. The aniseed oil deteriorates on lengthy storage, especially if care is not taken to properly exclude light and air, and slowly loses its capacity to crystallise until, finally, it will no longer congeal. The specific gravity increases even above 1.0, the refractive index is reduced,

and the oil becomes more readily soluble in 90 per cent. alcohol. Badly stored oils are naturally inferior, both in odour and in taste. Anise oil should be used only when fresh. If it has solidified, it should be completely melted and mixed before use.

The anise herbs cultivated in India yield the same constituents on distillation as the other varieties and are in no way inferior. Most of the oil of commerce, however, is derived nowadays from *Illicium verum* (the star anise), N. O. Magnoliaceæ which is indigenous to Southern China and Tongking and is also extensively cultivated in those parts. This is an evergreen tree about 4 to 5 m. in height and gives sustained yield of fruit which is available at a much cheaper price than the true anise. The two oils are practically identical except that the true anise oil has a more delicate odour and flavour than the star aniseed oil. The characters are given below. The content of anethole which is supposed to be the chief constituent is practically the same.

	True Anise Oil (<i>Pimpinella anisum</i>)	Star Anise Oil (<i>Illicium verum</i>)
Sp. gr. at 20°C	0.975 to 0.990	0.980 to 0.990
Optical rotation	0 to -2°	0 to -2°
Refractive index	1.552 to 1.558	1.5530 to 1.5565
Congeaing point	+15° to +19°	+15° to +17°
Melting point	16° to 19°	16.5° to 19°

Both these oils have been made official and, therefore, may be used freely in medicine. The pimpinella oil is said to have a slightly superior flavour but most of the anise oil used is that from the star anise. In commerce also, star anise has been used for some years, as the sole raw material for the manufacture of anethole or anise camphor. These facts have greatly discouraged even the Russian producers of true anise and the cultivation is said to be declining. Star anise of the particular species which yield the oil of commerce is not available in India but there are the other two species viz., *Illicium griffithii* Hook. f & Thoms and *I. manipurens* Watt ex King. Not much is known about these species except that the fruits of *I. griffithii* of Bhutan and Khasia Hills (4,000 to 5,000 ft.) is tasteless at first but soon afterwards develops a flavour between that of cubebs and hay leaves. The fruit like that of the true anise, is said to yield on distillation an essential oil somewhat resembling that of aniseed and fennel.

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PINUS LONGIFOLIA Roxb. (Pinacæ)

CHIR PINE

VERN.—Sans.—*Sarala*; Hind.—*Saral*, *Chir*, *Chil*.

Turpentine is obtained by steam distillation of the oleoresin which exudes when the sapwood of various coniferous trees is injured; the flow of sap is produced as a protection to injured parts. The name is sometimes applied, in a

broader sense, to include oil obtained by dry distillation or in other ways from pine saw-dust or pine wood. This oleoresin yields about 20 per cent. of oil of turpentine and about 80 per cent. of residue which is very largely used under the name of 'colophony' or resin. The rectified oil, *oleum terebinthinæ rectificatum*, is used very commonly in medicine but the demand for it is not very large. In the field of industry, however, turpentine is used to an enormous extent. It is largely used in the perfume industry and in the manufacture of artificial camphor. The largest amount is consumed in the manufacture of paints and varnishes. A considerable quantity of the resin is also used for the adulteration of shellac, in the preparation of varnishes, in the manufacture of paper, in soap factories, etc.

The conifers are widely distributed in all parts of the world, those growing in the temperate and tropical regions yield the best resin, while those of colder climates give a smaller yield and have a shorter producing season. The United States of America possesses vast forests of pine on the coasts of the Atlantic and the Gulf of Mexico, amounting to about 10 million acres. Huge quantities of turpentine are produced there and it has been estimated that nearly 67 per cent. of the world production is derived from there. The pine forests are very systematically worked in that country and all methods of wasteful exploitation are forbidden by the State laws in order to prevent exhaustion of the supplies. The following species are particularly important: (i) In the south and south-eastern U.S.A., *P. palustris* Mill. (*P. australis* Michaux) the long-leaf pine; *P. caribaea* Morelet (*P. heterophylla* Sudworth); (ii) in France *P. maritima* Lam. (*P. pinaster* Solander); (iii) in India *P. longifolia* Rox. That enormous quantities of turpentine oil are produced will be seen from the fact that in 1925-26, 480,000 barrels of 50 gallons each and 1,599,000 barrels of 500 lb. each of resin were released from the factories. France occupies the next position in the world trade in turpentine products and commands nearly 22 per cent. of the world production. It is interesting to note that this huge industry has been developed only within the last century. The centre of the industry is at Bordeaux and it occupies a triangular region called the 'Landes' whose base extends for 40 miles along the coast adjoining the Atlantic Ocean. 'Landes' was formerly a waste, sandy desert submerged in winter and dried up in summer, entirely worthless and unfertile. Cultivation of pine was started at the beginning of the nineteenth century and the soil was reclaimed and gradually improved between 1803-64 by the erection of artificial dams, proper drainage and cultivation of sand-binding grass. Today, France has in the 'Landes' more than a million hectares of pine forests chiefly consisting of *P. maritima* and *P. sylvestris*, producing turpentine oil and colophony in enormous amounts. There are nearly 180 turpentine factories scattered throughout the 'turpentine district' and in 1926 turpentine oil valued at 7,681,000 francs was exported. Spain, Portugal and Greece also possess flourishing industries in turpentine oil and its products.

India is very rich in her pine resources. Five species of pine are found in India of which 3 may be regarded as important from the point of view of turpen-

tine production. These are *P. longifolia*, *P. excelsa* and *P. khasya*. *P. excelsa* (the Kail or blue pine) occurs in the temperate Himalayas and occupies about 60,000 acres in the Uttar Pradesh and in the Punjab. The trees are somewhat inaccessible and it is doubtful if commercial distillation will be possible as the yield of oleoresin is rather low. *P. khasya* (the Dingsa or Khasia pine) occurs in the Khasia Hills, the Lushai Hills, the Chittagong hill tracts, in the Shan Hills and in hills of Martaban in Burma. Indian turpentine available in the market is produced chiefly from *P. longifolia* Roxb., (the 'Chir' pine), one of the most important trees of India. Extensive pine forests are distributed on the slopes of the Himalayas at elevations of 2,000 to 6,000 ft. in the mountainous regions from Afghanistan through Kashmir, the Punjab and the Uttar Pradesh to Bhutan, Assam and Upper and Lower Burma, amounting to over two million acres. These are distributed roughly as follows: Uttar Pradesh 10,00,000 acres, the Punjab 2,70,000 acres, Kashmir 692,000 acres and N. W. F. P. (Pakistan) 23,000 acres.

ECONOMIC ASPECTS.—The economic possibilities offered by these pine forests need no emphasis. Attention was directed towards the working of the 'Chir' pine for resin nearly 40 years ago. The original experiment was conducted under the auspices of the Forest Department and as soon as it was proved that the turpentine and resin from the Kumaon forests were readily saleable, systematic operations began in the Nainital Forest Division with 10,000 trees and a distillery was erected at Bhowali on a site 5,500 ft. above the sea level with excellent facilities for water supply. Later, a factory was opened at Jallo near Lahore and since 1914 turpentine and resin have been produced there on a large scale. In 1925 the quantities sold amounted to about 147,000 gallons of turpentine oil and 45,000 maunds of colophony. A new distillery fitted with modern equipment was started at Clutterbuckganj near Bareilly in 1920 and is also turning out the pine products on a large scale. Tapping for the oleoresin is now carried on in West Almora, East Almora and Nainital in the Uttar Pradesh and in certain places in the Punjab. Resin and turpentine factories have been set up in Jammu, Kashmir and Himachal Pradesh also to tap the natural resources. All the pine forest reserves cannot be profitably worked for production on account of the distance of these forests from the railway and the consequent increase in the cost of transport. In spite of this disadvantage the production of Indian turpentine is rapidly increasing. In 1913-14 turpentine valued at £28,319 and resin valued at £33,150 were imported into India. In 1917-18 according to reports of the Overseas Trade Department, 276,000 gallons of turpentine were used in India, of which 140,772 gallons were imported and 136,052 were actually manufactured in the country. It was also estimated that in ten years from that date the output of Indian turpentine will be increased to something like 300,000 maunds of resin and 800,000 gallons of turpentine. The expectation with regard to the increased yield of turpentine has been fulfilled. India has now practically become self-supporting and is even doing export of the products to other markets. There are, however, difficulties to be faced. American and French turpentine is mostly composed of 'terpenes', chiefly the 'pinenes', but the Indian turpentine consists

mainly of two other hydrocarbons 'carene' and 'longifolene'. The Indian turpentine, on account of the absence of pinene, cannot be employed in the camphor industry. It also undergoes easy oxidation and leaves a high percentage of resin on evaporation and hence is considered to be inferior to the other products. But Indian turpentine can be used in many industries in place of the American or the French though the composition varies to a certain extent.

Oil of turpentine is used externally as a counter-irritant and rubefacient. Small doses of oil of turpentine are given internally for bronchitis and phthisis, and larger doses as an anthelmintic. An oil of turpentine inhalation is sometimes used for bronchitis, but terebene is usually preferred for this purpose. Terebene is prepared from oil of turpentine by the action of cold sulphuric acid, which converts the pinene into the optically inactive dl-limonene, which is known as dipentene.

Colophony contains several isomeric forms of the anhydride of abietic acid, which are present to the extent of more than 80 per cent. These anhydrides were named by Tschirch and Studer (1904) α -, β -, and γ -abietinic acid, but the name abietic acid is often applied to them. The parent acid, abietic acid, has the formula, $C_{20}H_{30}O_2$, and is thus isomeric with pimaric acid. The commercial so-called abietic acid is prepared by digesting colophony with weak alcohol. Colophony also contains a resin, the bitter-tasting colophenic acids and traces of volatile oil. The amount of colophony used in pharmacy for the preparation of plasters, ointments, etc., is relatively small. Large quantities of the darker grades B, C, and D are destructively distilled to yield "rosin spirit" and "rosin oil" or are employed in the manufacture of linoleum and dark varnishes. Grades E, F, and G are used as size. The medium grades are largely used for the manufacture of soap and the lighter grades for sealing-wax, light varnishes, and in pharmacy.

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PIPER CUBEBA Linn. (Piperaceæ)

CUBEBS, TAILED PEPPER

VERN.—Sans.—*Sugandhamuricha*; Hind., Beng. and Bomb.—*Kabab-chini*;
 Tam.—*Val-milaku*; Tel.—*Chalavamiriyalu*; Pers. and Arab.—*Kibabeh*.

This is a climbing, woody bush indigenous to Java, Sumatra and the Malay Archipelago and is cultivated to a small extent in India. The fruit commonly known as cubebs has been extensively used as a condiment, particularly in the tropics. Old Arabian and Persian physicians are said to have used the fruit in genito-urinary diseases. Its use in the Western medicine can be traced to the middle ages. The English name is probably derived from the Arabic 'Kibabeh'. The fruit owes its activity to the presence of an essential oil which occurs to

the extent of 10 to 15 per cent. This oil has a pleasant characteristic odour and a greenish to greenish-blue colour and is used, though to a small extent, in genito-urinary diseases like cystitis, gonorrhoea and gleet.

The chemistry of the oil of cubeb has not been very thoroughly worked out but the following constants are known: specific gravity 0.910 to 0.930; optical rotation -25° to -40° ; refractive index 1.486 to 1.500. The solubility in alcohol also varies but most samples require as much as 10 volumes of 90 per cent. alcohol.

Though not indigenous to the Indian soil, *P. cubeba* has been grown in the Mysore State. Rao, Sudborough and Watson (1925) have studied the oil distilled from cubebs experimentally grown there. They were able to obtain 11.85 per cent. of the oil with the following constants: specific gravity 0.9167; optical rotation -29.9° ; refractive index 1.4894; saponification value 0.5 and saponification value after acetylation 24.1.

TABLE XII

(Fractionated at 685 mm. pressure) Indian Cubeb Oil		B. P. Cubeb Oil	
Temperature in Degrees Centigrade	Per cent.	Temperature in Degrees Centigrade	Per cent.
Between 140 to 170	5	Below 200	5
„ 170 to 225	20	Between 200 to 230	11
„ 225 to 245	15	„ 230 to 240	3
„ 245 to 265	45	„ 240 to 250	15
„ 265 to 280	10	„ 250 to 255	31
Residue and Loss	5	„ 255 to 257	25

It will appear from a study of the Table XII that in the case of genuine oil 56 per cent. distils over between the temperatures 250° and 280° , whereas in the case of the Indian oil 55 per cent. distils over within practically the same range of temperature. The difference, therefore, between the two specimens is negligible and it appears to be probable that the Indian oil is in no way inferior in medicinal properties to the oil of commerce. If cubebs are grown more abundantly, there is a reasonable possibility of the production of this oil for medicinal and other purposes.

According to Trease cubebs yield 10 to 18 per cent. of volatile oil containing terpenes and sesquiterpenes, a crystalline inodorous substance cubabin, a white amorphous substance cubebic acid (1 per cent.) and amorphous resin (3 per cent.). Cubebin and cubebic acid give a red colour with sulphuric acid. Good cubebs yield not more than 2 per cent. of acid-insoluble ash and not less than 13 per cent. of volatile oil. In western medicine the drug has been employed in gonorrhoea and in chronic bronchitis but is now little used. Cubeb acts as stimulant to the mucus membrane owing to its local irritant action. Its active principles appear to be capable of being absorbed and eliminated through the kidneys, exerting their characteristic effects upon the mucus membrane of the genito-urinary tract. It is used internally as an antiseptic and diuretic in gonorrhoea and in the form of lozenges as a stimulating and antiseptic expectorant to the bronchial mucus membrane.

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PODOPHYLLUM HEXANDRUM Royle. (Berberidaceæ)

Syn. *Podophyllum emodi* Wall.

INDIAN PODOPHYLLUM

VERN.—Hind.—*Papra*, *Papri*, *Bhavan-bakra*, *Bakra-chimyaka*; Kash.—*Ban-wagan*; Punj.—*Ban-kakri*, *Gul-kakru*, *Marathc-padwall*.

Indian *Podophyllum* is a small herbaceous plant met with in the higher shady temperate forests of the Himalayas from Sikkim to Kashmir at a height of 7,000 ft. above the sea level. In Kashmir, it occurs at an altitude of 6,000 ft. and chiefly abounds on the northern slopes of the mountains where the sun does not shine so strongly. It is also plentiful on the northern forest-clad slopes of the Shalai Hills, east of Simla. In the higher ranges of Kangra, Kulu and Chamba there are many rich forests whose glades are almost exclusively covered with this herb and large quantities are collected for sale. The plant attracted the attention of the ancient Hindu physicians and in the indigenous medicine the names 'papra' or 'nirbash' and 'bhavan-bakra' given to it show that its bile-expelling properties were fully known to them.

Podophyllum resin is used in medicine as a drastic purgative and as a cholagogue. The resin is derived from the rhizomes of *P. peltatum* (May apple or mandrake, Family Berberidaceæ) which is official both in the British and the United States Pharmacopœias. It grows plentifully in America. About 35 years ago, American *podophyllum* rhizome and the resin 'podophyllin', had a very wide sale in England and on the Continent. The resin was also imported into India during that period as the composition and properties of the Indian drug, *P. hexandrum*, were not fully recognised. Watt, many years ago, carried out investigations regarding its claims as a substitute for the official drug and found that Indian *podophyllum* contained about 3 times the resin present in the American *podophyllum* met with in commerce. Dymock and Hooper (1889) found 10 per cent. of the resin and Umney (1892) 12 per cent. in the Indian *podophyllum*, while estimations of resin in four specimens of the rhizome of *P. peltatum* by Henry and Dunstan (1898) gave respectively 4.17, 5.2, 5.4 and 5.2 per cent. From these figures the greater value of the Indian plant as a source of resin may be easily appreciated. The Indian plant seems to possess a further advantage over the American drug of commerce in that it contains a higher percentage of 'podophyllo-toxin' on which the purgative action of the resin partly depends. This will be seen from the Table XIII in which the percentage of resin as well as the percentage of podophyllotoxin from both the Indian and American rhizomes are given side by side.

TABLE XIII

Variety	District or place of origin	Quantity of rhizome used	Percentage of podophyllotoxin found	Percentage of resin found
<i>Podophyllum hexandrum</i>	Kulu (Punjab)	11.92 gm.	2.8	9.55
Do.	Bashahr (Punjab)	32.46 "	3.5	9.0
Do.	Chamba (Punjab)	9.81 "	4.7	11.12
Do.	Hazara (N.W.F.)	11.6 "	2.9	—
<i>Podophyllum peltatum</i> (U.S.A.)	U.S.A.	11.35 "	0.77	5.2
Do.	Do.	23.55 "	0.9	4.17

An estimation (1926) of the Indian rhizome gave 10.02 per cent. of the active principles which amply bears out the findings of the previous workers. Therapeutically, the resin from the Indian variety has also been found to be quite as active as, if not more than, the imported root.

CONSTITUENTS.—According to Trease the active principle of podophyllum is contained in the resinous mixture known as Podophyllin, prepared by pouring an alcoholic extract of the drug into water and collecting and drying the precipitate. American podophyllum yields from 4 to 5 per cent. of this resin, whilst Indian podophyllum (q. v.) yields from 8 to 13 per cent. of a similar mixture. Podophyllum Resin B. P. may be obtained from either drug, although physiological experiments indicate that the Indian is about twice as active as the American. According to Viehoveer and Mack (1938) the only active crystallisable substance isolated from either podophyllum or podophyllin is podophyllotoxin. It appears likely that this is not the chief cathartic principle, which still awaits isolation. Podophyllotoxin, isolated in an impure form by Padwyssotaski (1881), was obtained crystalline by Kuersten (1891). It is a complex tricyclic compound of the formula, $C_{22}H_{22}O_8$. It is highly toxic and sparingly soluble in water and is unstable in aqueous or alkaline solution yielding podophyllic acid, $C_{22}H_{24}O_8$, and picropodophyllin (the isomer of podophyllotoxin and the anhydride of podophyllic acid). The latter usually forms as a gelatinous precipitate, although it has recently been prepared in a crystalline form. The formation of this gelatinous precipitate when podophyllotoxin is treated with alkalis is used as a test to distinguish the American and Indian resins since the latter contains more podophyllotoxin. Structural formulae have been proposed for podophyllotoxin, podophyllic acid and picropodophyllin. Podophyllum resin also contains the yellow, crystalline flavonol, quercetin. The drug also contains abundant starch, calcium oxalate, and some fixed oil.

Indian podophyllum closely resembles American podophyllum in constituents, but the amount of resin (8 to 13 per cent.) and podophyllotoxin is greater. The

resin usually contains about twice as much podophyllotoxin as that prepared from *P. peltatum* and can be distinguished by the Pharmacopoeial test based on the relative solubilities of the two resins in ammonia or by the gelatinisation with aqueous potassium hydroxide. The drugs may be distinguished chemically by adding a few drops of strong solution of copper acetate to a filtered alcoholic extract prepared from each. *P. peltatum* gives a bright green colour and no brown precipitate, while *P. hexandrum* gives a brown precipitate.

ECONOMIC ASPECTS.—Even with all these advantages, *P. hexandrum* from the Indian sources could not compete with the American variety and most of the drug manufacturers in India were using the American product in their factories. The reason is not far to seek. The collection of the podophyllum rhizome growing so extensively in India was never carried out scientifically with the result that no standard of uniformity of the drug was maintained. We understand that formerly there was a podophyllum plantation in Hazara where the drug used to be cultivated but this was abandoned since 1913. Podophyllum collected in all seasons, localities, and elevations does not contain the same amount of resin nor does the resin yield the same amount of active principles, podophyllotoxin and podophyllo-resin. Hap-hazard collection without any attention to these principles has damaged the reputation of the drug to a great extent, and as there is no systematic cultivation to ensure regular supplies, the manufacturers find it difficult to rely on the crude drug obtained from the merchants and collectors.

Recently, the Indian manufacturers have taken up the manufacture of the resin from the Indian podophyllum. Most of the Kashmir grown podophyllum manufactured by the Drug Research Laboratory which compares favourably with the podophyllum resin of B. P. standard was sold in foreign market. The chief supplies of the podophyllum come from Virginia, North Carolina, Kentucky, Indiana and Tennessee. It is consumed in large quantities in U.S.A. As reported it grows wild in India, although its cultivation on short scale has been attempted in Kashmir and Himachal Pradesh States. The drug is collected in spring or autumn. That collected in autumn has a lower resin content in comparison to that collected in spring. The rhizomes are dug up, washed, cut into cylindrical pieces and carefully dried. The Indian drug pushed itself into the market during the Great Wars when the foreign supplies were restricted or practically cut off, but the situation has changed again. Unless more attention is paid to proper collection and drying of the rhizomes or the plant is systematically cultivated in suitable places, it appears unlikely that the Indian drug will be utilised even in India where the American drug is offered at a very low price. Cultivation of podophyllum is not difficult. In upland localities with sufficient moisture, the growth is very satisfactory, and within two to four years rhizomes are fit to be collected and sent to the market. Its cultivation in the Sikkim Himalayas will very probably meet with great success. It will grow best between 9,000 to 14,000 ft. but it may be tried at lower levels between 6,000 to 9,000 ft. It thrives best in grounds of shady forests or in an open area of woodland.

ACTION.—Podophyllin greatly irritates the eyes and the mucous membranes

generally. The resin does not affect the unbroken skin but may be absorbed from raw surfaces and give rise to purging. It is an active purgative and is administered in average doses of 0.01 gm; in toxic doses it produces intense enteritis which may result in death. Podwyssotski attributed the laxative action of the drug solely to podophyllotoxin. In crystalline form it is intensely toxic to dogs and cats; 0.005 gm. injected subcutaneously killed a cat. With subcutaneous injection the following symptoms were observed by him in dogs; effects on the nervous system became manifest very soon after injection, with disturbances of co-ordination in the posterior extremities; rapidly increasing weakness became noticeable, which however, was not always in direct relation to the violence of gastro-intestinal symptoms; respiration was greatly hurried and there was a great lowering of temperature; death usually occurred with the animal in a comatose state. Several violent clonic cramps were also observed before the termination of life. In post-mortem, the mucous membrane of the stomach is reddened; the intestines are generally strongly contracted but the mucous membrane is less hyperaemic; the liver is dark and full of blood and the gall bladder is frequently distended.

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PSYCHOTRIA IPECACUANHA Stokes (Rubiaceæ)

Syn. *Cephælis ipecacuanha* (Brot.) A. Rich.

VERN.—Ipecacuanha, Ipecac.

Ipecacuanha is a well-known drug which is official in the pharmacopoeias of many countries. It is the dried root of *P. ipecacuanha* (now called *Cephælis ipecacuanha*) which is a native of Brazil and is extensively exported from Rio de Janeiro to different parts of the world. Two other varieties of Ipecacuanha namely 'Minas ipecacuanha' (cultivated in Minas Geraes in Brazil) and 'Johore ipecacuanha' (cultivated in Johore and Selangor in the Federated Malay States) are recognised by the British Pharmacopoeia. Another variety, 'Carthagera ipecacuanha' derived from *C. acuminata* Karsten in Columbia is also met with in commerce. The root of this variety is thicker, darker and its annulations are less marked as compared to the Rio or Brazilian ipecac. which is slender and tortuous varying in colour from brick-red to dark-brown. The Ipecacuanha plant grows about 30 cm. in height and, from the slender root and prostrated stem,

roots are given off at intervals. Some of these growths develop an abnormally thick bark and this thickened bark and thickened root constitute the drug of commerce. It is found in most parts of Brazil growing in a state of nature and is also cultivated in some of the provinces of that country for purposes of export. The exported ipecacuanha is largely sold in the markets of India.

INDIAN SUBSTITUTES OF IPECACUANHA.—Ipecacuanha is not a native of India but from time to time a number of plants have been reported to possess similar properties and have been suggested as substitutes. *Naregamia alata* (Goanese ipecacuanha) N.O. Meliaceæ, Vern.—Mar.—*Tinpani, Pittvel*, is a small glabrous, undershrub with trifoliate leaves found in Western and Southern India and has been said to possess properties akin to Ipecacuanha. It was tried in Madras in acute dysentery and also as an emetic and expectorant with indefinite results. It contains an alkaloid called *naregamine* which is not related in any way to emetine. Under the name of East Indian root, the rhizome of small monocotyledonous plant, *Cryptocoryne spiralis*, N.O. Aroideæ, known in Tamil as *Nattu-ati-vadayam*, has been exported from Madras, but it contains neither emetine nor cephaeline. *Tylophora asthmatica*, (*T. indica*) N.O. Asclepiadæ, Vern.—Hind.—*Jangli pikvan*, Beng.—*Antamul*, Tam.—*Nay-palai*, is another plant which is still used as a substitute and some believe with satisfactory results. It is a small twining plant, common in the forests throughout eastern India, Bengal, Assam, Kachar, Chittagong, Deccan and Burma. It was first brought to the notice of the practitioners of Western medicine by Roxburgh many years ago. O'Shaughnessy confirmed Roxburgh's opinion and said that the emetic properties of the roots are well established and that it affords an excellent substitute for ipecacuanha. The properties of this plant so convinced the early workers that it was admitted as official in the Bengal Pharmacopoeia of 1844. On the compilation of Pharmacopoeia of India in 1868, the leaves were made official in preference to the root as they produced more uniform and certain results. It contains two alkaloids tylophorine and tylophorinine. It is used as a substitute for ipecac in bronchitis and dysentery. *Asclepias curassavica* is still another plant which was introduced into India from the West Indies and has become completely naturalised to India. It now grows wild in many parts of South India and in Bengal. The root of this plant possesses emetic properties and hence the West Indian colonists gave to it the name of 'bastard or wild ipecacuanha'. The active principle, however, is a glycoside *asclepine* and not the alkaloid emetine. The roots possess emetic properties. Besides these there are several other herbs in the indigenous system which have been claimed as substitutes for Ipecacuanha, e.g., *Anodendron paniculatum*, *Calotropis gigantea*, *Gillenia stipulacea*, *Euphorbia ipecacuanha*, *Baerhaavia decumbens*, *Sarcostemma glabra*, etc. Though detailed chemical and pharmacological studies of these drugs have not been made, it has been shown that none of them contain emetine or its allied alkaloids, but in most cases contain irritant substances which are responsible for their emetic properties. Some of these remedies have been actually tried in the treatment of amoebic dysentery but without success.

Ipecacuanha is a drug of very great importance to India in view of the wide prevalence of amoebic dysentery in this country. An analysis of a large number of stools examined in the Department of Protozoology, Calcutta School of Tropical Medicine showed a general incidence of 14 per cent. and from this the large demand for this drug can be easily estimated. As the drug was not grown in India large quantities of the crude drug and also the alkaloid emetine were imported every year. Good quality of ipecacuanha root can be grown in India and sufficient quantities could be produced to meet the demand. The Government of India were not slow to appreciate the advantages likely to ensue by such an enterprise and as early as 1916-17, ipecacuanha plantations were started in the Nilgiris and at Mungpoo near Darjeeling. Later, plantations were also started in Burma. The

plants seeded well and it appeared from the reports for the year 1920 that there was every chance of the cultivation proving a success if plants could be reared from the seeds sown. The report for the year 1922 showed that the ipecacuanha plants were doing very well, their numerical strength had considerably increased and extensions to the existing nurseries were being contemplated. The prospect appears to be very hopeful but there are certain difficulties. Excessive daily fluctuations of temperature seem to affect the plantations badly and unless very elaborate arrangements are made to counteract them there is chance of the whole stock degenerating. In spite of these difficulties, the stocks of the Mungpoo and other plantations have so far done well and it is understood that nearly 226,496 plants were grown in Mungpoo alone. In the Burma cinchona plantations, nearly 668,852 plants had been reared. The quality of root produced is quite satisfactory as will be evident from the following statements which give the comparative figures of the total alkaloids and emetine contents of the different roots on the market.

			Total Alkaloids	Emetine
Brazilian root	....	...	2.7 per cent.	1.35 per cent.
Brazilian stem	..	..	1.80 " "	1.18 " "
Columbian root	....	..	2.20 " "	0.89 " "
Indian root	...	..	1.98 " "	1.39 " "

A perusal of the above figure will show that the emetine content of the Indian root compares very favourably with the Brazilian root though the total alkaloids are not so high. The Columbin root is very rich in total alkaloids but the proportion of emetine is very small for commercial purposes. Emetine in a pure condition, obtained from the Indian ipecacuanha, is now available on the market, but the quantity is insignificant compared to the demand. Ipecacuanha is now being grown on a commercial scale in West Bengal hill tracts.

CULTIVATION.—Attempts have been made to grow ipecacuanha in other parts of the world. In Java and Ceylon the cultivation did not prove a success but in the Straits Settlements and the Federated Malay States the plant did very well especially in the rubber plantations, and ipecacuanha root of an unusually fine appearance and rich in alkaloids is now exported in considerable quantities. In India a survey of the climatic and edaphic requirements of the plant suggests that the plant may be tried with success at Jorhat (Assam); Chittagong (Cox Bazar, E. Bengal); Sundarbans (Moralganj, Kaliganj, Bengal); Jalpaiguri district (Bengal); Balasore district (Orissa) and in the hilly tract of the Meghasini range. The plant is grown at Mungpoo at an altitude of 1,200-1,500 ft. with an annual rainfall of about 120 in. per year and maximum temperature in summer about 100°F, and no frost during winter. The plant prefers a rich sandy, alluvial loamy soil and this should be rough in texture and well drained. The following composition is likely to suit the requirements of the plant: 1 part clean washed sand, 1 part well decayed leaf-mold, 1 part ordinary soil (i.e., rich friable loam), 1 part oil lime rubbish, 2 parts pounded brick, 2 parts oil and dried cow dung manure. A

judicious supply of calcium phosphate and some magnesia and potash salts give favourable growth to the plant.

The plants may be raised from seeds or cuttings but the latter ones are more vigorous and healthy. The seeds take a long time, sometimes 6 months to germinate and only about 30 per cent. of the seeds germinate. Propagation from cuttings may be effected from the roots, shoots or leaves. The root cuttings and leaves should be placed in pans not less than 3 in. deep containing very fine sand. The plants must be kept constantly damp but never saturated with water. The pans containing the plant must be kept under cover where they will have free ventilation but special care must be taken to protect them from direct rays of the sun. The leaves may be expected to form callus in about a fortnight to three weeks; after this a mass of fibrous roots grows out from the callus and then one, two, three or even four young shoots make their appearance above the ground. When these latter shoots are about an inch and a half in height, they may be separated and potted off. The root cuttings may be prepared by slicing the roots into small pieces about $\frac{1}{2}$ in. long and then placing them in beds containing 2 parts of sand and one part of humus. The cuttings should be watered regularly and kept in shade. The shoot cuttings strike roots more quickly than the root cuttings which strike roots in about a month time. At the end of two months they should be transplanted in another bed containing equal parts of sand and 'jungle' mold, and should be placed 4 in. apart. After another 4 months the plants may be put in permanent beds under shade. Plants should be put at least 1 ft. apart in permanent beds under shade and this will give room for development of the plant. The roots are harvested generally at the end of three years, counting from the time of sticking the root in case of raisings from cuttings and in case of seedlings from the time the plants open up the leaves. It is on record that $2\frac{1}{2}$ years old plants from Johore gave highest yield of the alkaloid. The roots are prepared for the market by drying them as quickly as possible, the common method employed is sun-drying, the roots being placed under cover at night to avoid damp caused by dew. Drying can be accelerated considerably by using artificial heat without affecting the quality of roots. Average yield of roots is about 600 lb. per acre.

CONSTITUENTS.—The roots contain the alkaloids emetine, cephaeline, kryptonine, and psychotrine, along with o-methylpsychotrine and emetamine. It also contains ipecamine and hydro-ipecamine along with a glycoside termed ipecacuanhin, ipecacuanhic acid, starch, calcium oxalate, etc. Psychotrine can be converted either into o-methylpsychotrine or into cephaeline, which in turn, upon methylation yields emetine. It was found that Brazilian roots contain about 2.5 per cent. of total alkaloids of which about 70 per cent. is said to be emetine whereas *Cartagena ipecacuanha* roots yield about 2 per cent. of alkaloids of which less than half is emetine. The percentage of alkaloids obtained from Indian Ipecac roots are given in the Table XIV.

TABLE XIV
PERCENTAGE OF TOTAL AND NON-PHENOLIC ALKALOIDS
AND ASH IN TERMS OF DRY WEIGHT OF ROOTS

<i>Age of Plant Year</i>	<i>Total Alkaloids per cent.</i>	<i>Non-Phenolic Alkaloids per cent.</i>	<i>Ash per cent.</i>
1.	1.45 to 2.30	1.81 to 1.20	2.89
2.	1.70 to 2.33	1.21 to 1.24	2.00
3.	2.33 to 2.50	1.35 to 1.40	2.25
4.	2.14 to 2.60	1.21 to 1.33	1.68
5.	2.45 to 2.51	1.30 to 1.34	

The percentage of alkaloids in plants grown at Derdang, in the Federated Malaya States, is much higher than that grown in India and as much as 3.1 per cent. of total alkaloids with 1.6 per cent. of emetine has been found in roots obtained from Federated Malaya States.

PHARMACOLOGICAL ACTION.—Emetine and cephaeline, the two chief alkaloids of ipecacuanha, resemble each other closely in their effects, cephaeline being somewhat more irritant in action which is, however, much more marked in certain individuals than in others. After local application to the skin, they produce irritation and inflammation resulting in the formation of vesicles and pustules. When powdering the root, the operator must protect his face, as the fine powder is very irritant to the eyes, and when inhaled, elicits a violent reaction from the mucous membranes of the respiratory passages, profuse nasal catarrh, hoarseness, coughing, etc. The emetic action is mainly due to the irritating action of the alkaloids on the stomach, but it is possible that there may be further action on the medullary centre when large quantities are injected intravenously in animals.

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RHEUM EMODI Wall. (Polygonaceæ)

INDIAN RHUBARB

VERN.—Hind. and Beng.—*Revand-chini*; *Rheuchini*; Bomb.—*Ladaki-revanda-chini*; Punj.—*Rewand-chini*; Tam.—*Nattu-ireval-chinni*; Tel.—*Nattu-reval-chinni*.

Rhubarb is largely employed in Western medicine as a purgative. In the ailments of children it is specially valuable and has been very commonly used. In fact, it is one of the everyday nursery remedies. It has been used in medicine for 4700 years or longer, since it was described in the early Chinese work on

materia medica, called 'Shen-Nung-Pentsao-King' (ca. 2700 B. C.). The commercial rhubarb, known as Chinese, Russian and East Indian, is said to be obtained from *R. officinale* and *R. palmatum* which grow in South-East Tibet and North-West China. Rhubarb is brought from China through Persia and thence to India; it is also imported to a certain extent from London. In the Himalayas, *R. emodi* is found growing wild in various parts of Nepal and Sikkim to Kashmir, at altitudes of 4,000 to 12,000 ft., along with some of the allied species such as *R. moorcroftianum*, *R. Webbianum* and *R. spiciforme*. However, although *R. emodi* is the species most commonly referred to, Youngken is of the opinion that most commercial Indian Rhubarb as imported into U.S.A. represents *R. webbianum*. The Himalayan rhubarb is darker in colour and coarser in texture than the Chinese variety, is not decorticated and yields a brownish yellow powder instead of the bright yellow powder of the Chinese rhubarb. It was considered of little commercial importance as it was commonly believed to be of an inferior grade to the Chinese drug. Considerable quantities are, however, annually conveyed to the plains from the Kangra district of the Punjab and Kashmir for use in the indigenous medicine. Indian rhubarb was tried by the Indigenous Drugs Committee but was not found to be very satisfactory. The reasons adduced by the Committee are, however, not convincing. The following analysis by Elborne shows the percentage composition of various samples of English and East Indian rhubarb. It is evident from this that the Indian rhubarb is not lacking in the purgative principles (the anthraquinone derivatives) which characterise the foreign and official rhubarb.

	Rheum emodi (low cultivation)	Rheum emodi (high cultivation)	East Indian Rhubarb	Russian Rhubarb
Moisture	6.06	7.9	5.4	12.6
Ash	9.33	4.9	9.28	6.63
Mucilage soluble in water	6.5	4.8	4.0	5.5
Cathartic acid	3.5	3.2	4.5	3.2
Organic acids, <i>e.g.</i> , gallic acid, etc.	3.3	2.2	3.0	4.5
Resinous substance soluble in alcohol	2.6	2.0	4.6	5.2
Fat and free chryso- phanic acid soluble in petroleum ether	0.4	0.3	0.7	1.5

It has been found that rhubarb cultivated in India with due care is as good as the imported Chinese rhubarb. The root of *Rumex nepalensis* which grows abundantly in some parts of India is sold under the name of 'Rewandchini' in the bazars of Bengal. It has purgative properties similar to rhubarb, and is also used as a household remedy but no definite information is available regarding its usefulness as a substitute for the commercial rhubarb. Good rhubarb can be grown in India and systematic cultivation of this plant is likely to be a paying proposition. Rhubarb has already been successfully grown in certain parts of Assam but this is used mostly by the local people as food and not utilised in medicine.

CULTIVATION.—The plant is propagated from seed or by dividing the crown into a number of portions each bearing a bud. Planting should be done in early spring in a rich, deep soil treated with well rotted manure. The plants should be set 4 to 5 ft. apart each way with their crowns 4 in. beneath the surface. The rhizomes and roots are harvested in autumn. They are dug up late in September from plants 8 to 10 years old, washed, the crown and small branches removed and, after the removal of most of the bark, are either cut into pieces or segments and kiln or sun dried, or the segments may be bored with holes and suspended on strings to dry. The roots of other species of *Rheum*, specially *R. acuminatum* H. f. & T., *R. nobile* H. f. & T. and *R. webbianum* Royle are used as substitutes for *R. emodi* Wall.

CONSTITUENTS.—Rhubarb contains derivatives of anthraquinone, which are regarded as the purgative constituents and are present to the extent of 2.0 to 4.5 per cent. The astringent constituent consists chiefly of gallic acid in the form of glucogallin, which is glycosidal, together with small amounts of tannin and possibly catechin. Other constituents, apparently devoid of medicinal action are rheinolic acid, starch, fat, dextrose, levulose, pectin and calcium oxalate. The amount of calcium oxalate, and consequently also the ash, varies widely; the ash is from 3.5 to 43.3 per cent., good Chinese rhubarb yielding from 7 to 13 per cent. That the ash is due almost entirely to calcium oxalate is evident from the small acid-insoluble ash, which should not exceed 1 per cent. The anthraquinone derivatives present in rhubarb are rhein, emodin, aloë-emodin, emodin-monomethyl ether and chrysophanol. These occur partly free, partly as glycosides and possibly also in some other undetermined combination occurring in the amorphous resinous mass, extracted from rhubarb by Tutin and Clewer and referred to as rheonigrin, which yields on hydrolysis gallic and cinnamic acids together with the anthraquinone derivatives named above. According to Wallis (1946) the pieces of the drug Indian rhubarb (*R. emodi* Wall.) are a good deal shrunken and are soft and easily cut. In ultra violet light it fluoresces violet with a certain amount also of velvety brown patches. It does not contain rhaponticin, it gives a positive reaction for anthraquinone derivatives.

It is used as a purgative and astringent tonic. The tuber is pungent bitter and is also considered emmenagogue, diuretic and is reported to be used in billiousness, lumbago, heating of the brain, sore eyes, piles, chronic bronchitis, chronic fever, asthma, coryza, pains and bruises.

COMMERCE.—The commercial supplies of the commercial rhubarb, obtained from *R. officinale* Baill. are obtained in major quantities from China. It is collected chiefly in the mountainous country separating Tibet from the province of Szechuen and extending eastward to Hupeh. The commercial varieties of Chinese Rhubarb are Shensi, Canton and High Dried, of which Shensi rhubarb is esteemed as the finest variety. Pharmaceutical preparations made up with Chinese and Indian rhubarbs indicated that certain preparations (especially *Mistura Rhei* et *Sodae* and *Tinctura Rhei Aromatica*) made with the latter were closely similar

in appearance, etc., to preparations of Chinese Rhubarb. Some were less satisfactory (notably Pulvis Rhei Compositus) chiefly because the odor was much less pronounced. It is obvious from what has been said that genuine Indian Rhubarb represents an excellent replacement for the Chinese drug, as formerly available in the market. Although the Chinese Rhubarb is somewhat more effective as a cathartic and has the attractive feature of possessing a more pronounced and typical odour, yet on the other hand, the Indian article has certain advantages of its own and has been found quite satisfactory by the trade and by the profession in the United States and Great Britain.

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RICINUS COMMUNIS Linn. (Euphorbiaceæ)

CASTOR SEEDS

VERN.—Sans.—*Eranda*, Hind.—*Arand*, *Erand*; Beng.—*Bherenda*; Punj.—*Arand*; Bomb.—*Erendi*; Tam.—*Amanakkam-chedi*.

Castor oil is derived chiefly from the seeds of *R. communis*, but the seeds of certain allied species like *R. viridis*, etc., are also useful. Although apparently indigenous to Africa, *R. communis* grows so extensively in India that there has been a lot of speculation as to whether it is really a native of India. The plant has been cultivated in India for many centuries. Two forms are known: (a) A perennial bushy shrub or a small tree grown usually as a hedge plant which has large fruits and large red seeds yielding as much as 40 per cent. of the oil. This is used chiefly for illumination and lubrication purposes. (b) A much smaller, annual plant grown as a distinct crop has small grey seeds with brown spots which yields as much as 37 per cent. of the oil. This is used chiefly for medicinal purposes. The plant is cultivated throughout India, particularly in Madras, Bombay and Bengal, and large quantities of the seeds are exported.

CULTIVATION.—According to Yegna Narayan Ayer when castor seed is grown as a pure crop, yields up to 900 lb. of seed per acre are obtained from well grown crops and 400 to 500 lb., from average crops. Even poor crops yield 200 to 300 lb., per acre. The volume weight, however, varies materially according to variety.

The castor seed consists of 20 per cent. of husk or shell and 80 per cent. of the soft kernel which contains the oil. The unshelled or 'undecorticated' seeds contain from 40 to 53 per cent. of oil while the kernel contains 58 to 66 per cent. of oil. The small seeded varieties contain about 7 to 8 per cent. more oil than the large seeded varieties in their seeds. Much variation in the oil content of one and the same variety is caused by the stage at which the seeds are harvested. The difference between dead ripe seeds and those harvested earlier may amount to as

much as 9.5 per cent.; in fact this factor of maturity gives rise to a greater difference in the oil content than varietal characteristics such as the colour of the stems or the smoothness or otherwise of the capsules.

The fixed oil of the commerce is obtained from the seeds by two processes:

(1) *Cold Drawn*.—When extracted without the aid of heat it is colourless or faintly yellow or straw-coloured, practically odourless, with a bland and slightly acrid taste.

(2) *Hot Drawn*.—In India, this is done by boiling the seeds with water and skimming off the oil. The hot pressing process commonly in use in this country consists of burning a slow fire under the mill; this liquefies the oil and increases the yield. The oil is bleached by exposure to the sun and is clarified by boiling with water which coagulates the proteins and dissolves out the mucilaginous matrix.

There are several qualities of this oil in the market. For medicinal purposes, the seeds are hand-cleaned and husked, the kernels dried in the sun and afterwards broken in a crushing machine. It is understood that at present most of the oil is extracted by hydraulic presses in Calcutta, Bombay and South India. The advantage of this process is that it is less complicated and the acidity and nauseousness of taste commonly associated with the oil are avoided. Only half of the available oil is extracted by first pressure; the mass is subjected to a second pressure giving an additional 16 per cent, which is used as a lubricant.

CHEMISTRY OF CASTOR OIL.—The oil chiefly consists of ricinoleate of glycerol, or tricinolein with a small quantity of palmitin and stearin. Unlike most fixed oils, castor oil possesses the remarkable property of mixing with absolute alcohol and glacial acetic acid in all proportions. The glycerides of ricinoic acid, $C_{17}H_{32}(OH)COOH$ (which is a hydroxy acid) are mainly responsible for the purgative effect. When given by the mouth the oil is saponified and free acid is liberated which produces the effect. Apart from the oil which is contained in the kernels, a very toxic substance is also present in the seeds. This poisonous constituent is a body of albuminoid nature and is named *ricin*. In the body it produces an anti-toxin (antiricin); it is destroyed by heat. Ricin may be extracted by means of salt solution, precipitated by magnesium sulphate or other electrolyte and purified by dialysis. It is a powerful poison having a definite effect on the coagulation of blood, it has no purgative effect but produces hæmorrhagic inflammation of the gastro-intestinal tract even when given subcutaneously. It is not present in the oil to any extent. The seeds also contain lipases which under suitable conditions hydrolyse the glycerides and are sometime employed commercially for the preparation of glycerin from fats and oils. A crystalline alkaloid, ricinine, $C_8H_{15}O_2N_2$, was isolated and has now been synthesised. It is not markedly toxic.

According to Yegna Narayan Ayer, the castor oil has the following physical and chemical constants: Specific gravity at $14.5^{\circ}C.$, 0.959 to 0.969; refractive index at $40^{\circ}C.$, 1.4679 to 1.4723; viscosity at $100^{\circ}F.$, 1160 to 1190; saponification number 175 to 185; iodine number 82 to 90; Reichert-Miessl number 1.0 to 2.0. The oil does not become rancid; but if the decorticated kernels are stored for any length of time the lipase in the seeds acts and liberates the free fatty acids. If these seeds are used for making 'cold drawn' oil, then the fatty acids will pass into the oil and give rise to rancidity. Rancidity will also develop quickly if the seeds used for extraction are not quite dry but contain considerable moisture.

ECONOMIC ASPECTS.—Though the largest area under cultivation is in this country, considerable quantities of castor seeds are annually gathered and used for producing the oil in several West Indian Islands, North America, Algiers and Italy. The ricinus plant was known as an oil plant in ancient Egypt and there is also evidence to show that the oil has been known in India for a very long time. Both castor seeds and castor oil form important articles of commerce. Medicinally a considerable quantity of the oil is used all over the world. An enormous amount,

much larger than the quantity used for medical purposes, is consumed in the manufacture of soap, leather, oil and as a lubricant in air-craft engines and for other industrial purposes.

PRODUCTION AND TRADE.—The total area under castor in India including the States in 1937–38 was about 1.3 million acres. The largest area is grown in Hyderabad where the crop is grown on about 7,35,000 acres. The areas in Madras, Bombay and Mysore were 2,50,000; 42,000; and 96,000 acres respectively. India ranks as the largest source of the World's supply of castor seeds and castor oil. The export of the castor seed and of castor oil in the year 1939-40, were as follows: Castor seed 40,437 tons valued at Rs. 32 lakhs in round figures and Castor oil 12,53,750 gallons valued at Rs. 23 lakhs. In addition Castor oil cake is also exported to a small extent, which amounts to approximately 3,000 tons per year. Notwithstanding such enormous production it is disappointing to note that the best qualities of medicinal oil are not produced in India to supply even her own demands. Only crude oil is manufactured and this is mainly used for industrial purposes. The best oils for medicinal purposes are the Italian or French oils prepared by cold expression. The first pressing only gives a good quality of oil and a yield of about 33 per cent. is obtained from the seeds as compared to 40 to 45 per cent. which might have been obtained after the final pressing. The Italian and French oils are expressed from the seeds after they are decorticated and the husks removed; they are, therefore, milder in taste as compared with the Indian oils. Production of good medicinal oil in bulk does not present any special difficulties in India and there is every reason to believe that the extraction will be remunerative, and India will be able to meet her own requirements of one of the cheapest and most important purgatives of the Pharmacopoeia. Purification of the oil is also beset with no great difficulty. The Castor oil cake is a valuable fertiliser; but owing to the presence of the poison 'ricin' it is unfit for cattle feed. The oil cake will vary in composition according as it is prepared from 'decorticated' or 'undecorticated' seed. The former will contain 6 to 7 per cent. nitrogen and about 2.25 per cent. of P_2O_5 while the latter only from 3 to 4 per cent. of nitrogen and about 1.8 per cent of P_2O_5 .

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ROSA DAMASCENA Mill. (Rosaceæ)

THE ROSE

VERN.—Hind.—*Gulab-ke-phul*; Beng.—*Golap-phul*; Bomb.—*Gul*; Tam.—*Gulappu*.

The medicinal use of rose water and the oil or otto (attar) of rose is very limited. Rose water is mostly employed in lotions and collyria and the oil is used as a flavouring agent to mask the taste of many obnoxious preparations. In the Indian indigenous medicine, rose petals are used in the preparation of a laxative conserve called 'Gulkand'. It is, however, widely used in perfumery and is prized

in many countries for its delicious aroma. The chief centre of rose industry is Bulgaria where very extensive plantations are found in the valleys and southern slopes of the Balkan Mountains. It has been estimated that the producing area has an extent of 80 miles in length and 30 miles in width. The production is enormous. On an average 80,00,000 to 90,00,000 kilos of flowers are harvested annually yielding from 2,050 to 3,000 kilos of the essential oil. The following figures regarding the export of rose oil from Bulgaria in 1926 will show the importance of the industry and the demand in the various countries: France 1,455 kilos; United States 975 kilos; Germany 311 kilos; England 190 kilos; other countries 172 kilos; total 3,103 kilos. Besides this, a large quantity of rose extract was prepared which is steadily obtaining greater significance in modern pharmacy. Oil of rose is obtained by distillation from the fresh flowers of *Rosa damascena*, *R. gallica*, *R. alba* and *R. centifolia*. Rose is also cultivated in several other places in Europe, e.g., France, Italy, Greece and Germany. In the East, Persia has been famous for its otto of rose for centuries and it is even thought that distillation of rose first originated in that country. Most of the rose grown in that country is utilised for her own needs but sometimes dried petals are exported to India for the manufacture of rose water. The oil in Europe is prepared in copper alembic stills by the peasants or in large factories under careful scientific control. Some 3,000 parts of flowers yield only one part of oil. The oil is very expensive and very liable to adulteration. The 'peasant distilled' oil usually fetches a lower price than that produced in the larger works. The oil is exported in handsome metal 'vases' covered with felt ribbon in the Bulgarian colours, and customs seals. The oil is pale yellow and semisolid in consistency. The portion which is solid at ordinary temperatures forms about 15 to 20 per cent. and consists of odourless stearoptene. The liquid portion forms a clear solution with 70 per cent. alcohol. It consists of the sesquiterpene alcohols geraniol and citronellol, with smaller quantities of esters and other odorous principles. Although the alcohols form about 70 to 75 per cent. of the oil, the odour is so modified by the other constituents that no artificial mixture of the known constituents can be made to reproduce the odour of the natural oil.

In India at one time roses used to be cultivated very extensively. It is said that rose culture has been carried on at Ghazipur for nearly 250 years. To this day, Ghazipur remains the largest centre of rose production in India. It is also cultivated in Lahore and Amritsar in the Punjab, Kanpur, Aligarh and Hathras in the Uttar Pradesh and to some extent near Patna in Bihar and Orissa. Rose water is the chief product but very little true essential oil is extracted at present. In fact, the industry has gone down to a very low level. The quantity of rose water and otto produced in this country is not sufficient to meet the internal demands and therefore large quantities are imported from abroad. There is, however, an ample scope for a large rose-products industry in India. The rose grows best at altitudes of 900 to 1,500 ft. but it is cultivated up to 2,500 ft. and even 3,000 ft. The factors contributing to the successful cultivation of rose in Bulgaria, such as abundance of rain, sandy rich well-drained soil, sloping ground and the protection of the rose bushes from high winds, can be easily obtained in

many localities in India. It is also possible to grow in India the species of rose grown in Bulgaria namely *R. damascena* (red rose). Besides this, an enormous quantity of wild hill roses grow throughout the north-west Himalayas and Kashmir and are at present allowed to go waste. These too may be profitably utilised by adopting the same methods as in countries where perfume from wild flowers is extracted. At the same time, attention should be directed towards the improvement of the Indian roses which are at present poor in essential-oil contents as compared with the Bulgarian and French roses. By using freshly-plucked flowers and discarding the primitive methods of wasteful distillation, it has been reported that the yield could be increased from 0.004 to 0.025 per cent. With an average yield of 0.025 per cent. and the yield of flowers at 1,500 lb. per acre there would be no difficulty in competing with the Bulgarian product.

In their exploratory report on essential oils, Narielwala and Rakshit observed, "even today the small quantity of Rose oil that is produced in India is almost as good as the Bulgarian Rose oil and it is of vital importance to the country that the manufacture of Rose oil in India should be undertaken on a much larger scale than hitherto. Ghazipur, which was once known all the world over as the centre of Indian Rose oil, now produces roses on a very small scale on account of the degradation of the species and the impoverishment of the soil and the centre of gravity for the production of Rose oil has shifted to Barwana in Aligarh district of U. P. The season for roses in Barwana lasts for only six weeks from the middle of March till the end of April and it is reported that during this period as much as 200 mds. of rose petals are distilled per day and at the height of the season, which lasts for only about a week, the arrival of flowers comes to as much as 1,000 mds. per day. Most of the rose petals are, however, used up for the manufacture of Rose 'attar' and only about 5 to 7 lb. of pure otto of Rose is produced per annum. The distillation at Barwana is carried out by distillers from Kanauj by old methods and it is reported that about 13,000 lb. of rose petals give about 1 lb. of Rose oil (which means a yield of about 0.008 per cent.; this is in addition to Rose water which is obtained in the process). If a more modern method of distillation is adopted it should be possible to obtain a higher yield. Even with the present methods, were all the rose petals in Barwana to be used up for the distillation of Otto of Rose and not of attar, the production of Rose oil could be increased to at least 50 lb. per annum. Systematic study of the manufacture of Otto of Rose by modern methods has been carried out by the Industries Department of the Uttar Pradesh and they have stated that the yield of oil can be raised to as much as 0.015 per cent. by using an improved type of still, i.e., we can obtain from the existing crop of flowers at Barwana twice as much more oil than what the crude method of distillation yields. We consider a wider cultivation of roses and a production of Otto of Rose to be of immediate and considerable importance to India. We understand that in South India as much as 125 acres are under Rose cultivation, but no attempt has yet been made there for distilling Rose oil. *R. damascena* is the only suitable variety for the distillation of the oil, but a systematic study of the different varieties of Rose grown in India may reveal that some of the other varieties may be equally suitable for

distillation. We cannot too strongly recommend the development and extension of rose cultivation in India on a wider scale, as the price of Rose oil from the Balkans ranges from Rs. 600 to 1,000 per lb. and the importance of Rose oil to Indian economy can be easily gauged”.

Besides the oil, the fruit of rose (rose hips) is also used in U. K. and Europe as a source of Vitamin C. These are the incompletely ripe fruits of various species of Rose, including the common dog roses, *R. canina*, and downy-leaved roses, *R. mollis*. They are collected between the period when they just begin to change colour until they are fully red. To prevent loss of vitamins they are used for the preparation of galenical as soon as possible after collection. Rose hips are at present much used in Britain as a source of vitamins. Their high vitamin C content was pointed out in English samples assayed by Goldberg and Walsh (1938). According to Wokes *et al.* (1943) they are also good sources of vitamin P and carotin. The vitamins are unstable in the form of rose-hip syrup, but a stable dried extract may be prepared. Vitamin C is present in many fruits and vegetables, but vitamin P, although present in many fruits, is not usually abundant in vegetables. Rose hips also contain about 3 per cent. of malic and citric acids and up to 30 per cent. of sugar. Rose hips have long been used in pharmacy in the form of a confection, but their importance as a source of vitamins has been but recently appreciated.

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SANTALUM ALBUM Linn. (Santalaceæ)

SANDALWOOD

VERN.—Sans.—*Swet chandan*; Hind.—*Safed-chandan*; Beng.—*Sada-chandan*; Tam.—*Shandanak kattai*.

The wood of *S. album* (swet chandan) was highly prized during antiquity in India and China, on account of its peculiar odour. It has occupied a very important place in Hindu religious ceremonies. The Brahmins used a paste made from the wood for their sectarial marking. The Parsis used it for the fire in their temples. It was regarded as the most durable because it is not touched by the white ant which destroys so many other varieties of timber. Sandalwood is found mentioned in the earliest Sanskrit and Chinese literature. The Egyptians came to know about it as early as the seventeenth century B.C. It is a small evergreen tree possibly indigenous to India though opinions differ among the botanists as to the real locality of origin of the plant (Kew Bulletin No. 5). It either grows wild or is cultivated in Mysore State, Coorg, Coimbatore and the southern parts of Madras. The territory in India from which most of the

wood is obtained constitutes a strip of about 240 miles long and 16 miles wide, starting from the Nilgiri Hills and extending north and north-west through Mysore. In this region, the tree grows at altitudes from the sea level to about 4,000 ft. The total area of sandalwood plantations has been estimated to be amounting to nearly 6,000 square miles of which about 85 per cent. is in Mysore and Coorg.

The sandalwood tree is of a parasitic nature. A few months after germination, haustoria from the roots penetrate into the roots of grasses, small shrubs and herbs and eventually of large trees. The young plants are planted with some other young trees to serve the purpose of a host, in baskets made of the sheaths of bamboo leaves. The seeds are sown either in beds or two or three in a hole. In the latter case a capsicum seed is also introduced as this germinates very rapidly, shading the sandal seedling and at the same time giving it food. It is a delicate tree and suffers much from accidental injuries in the process of transplantation. It is also likely to be affected very commonly with a disease known as the 'spike' disease which is very infectious and destroys wide tracts, especially where the trees are close together. Much care, therefore, is needed in its proper cultivation. The influence of the soil plays a very important part in the growth of this plant. When grown away from its natural habitat, it tends to lose much of its essential oil for which it is esteemed in medicine. The trees growing on hard, rocky, ferruginous soils are richer in oil than those growing on fertile tracts. In fact the trees which are grown slowly in poor soil develop the most heartwood and are the richest in oil. Attempts are said to have been made to grow sandalwood and to distil the oil in other parts of India outside Mysore, but these have not met with much success. Records show that sandalwood oil used to be distilled in Kanauj (U. P.) some time ago but nothing more is heard about this enterprise, and it is likely that the industry has died a natural death on account of the scarcity of sandalwood in those parts. The trees mature in 18 to 20 years, when the heartwood is developed to within 2 in. of the surface. The tree is then ripe for felling. Preferably fully grown trees (27-30 years) are uprooted. The bark is removed and the white outer sapwood and branches which are odourless are rejected. The cleaned heartwood is then sawn into billets about 2½ ft. long, trimmed and kept for drying in a closed warehouse. This process is said to improve the aroma of the wood. The heartwood is equivalent to about one-third of the tree by weight.

SANDALWOOD OILS OF COMMERCE.—India is not the only country where sandalwood is grown. A small amount is obtained in Eastern Java in the Sandalwood Islands. The wood and sometimes the oil enters into commerce *via* Macassar (in Celebes) and is known as the 'Macassar sandalwood oil'. This oil, although the product of *S. album*, is not of as fine an odour as the Indian distillate. Woods of some other trees have, from time to time, been used as substitutes for genuine sandalwood and great confusion exists in view of the fact that these oils pass as sandalwood oil in commerce. The so-called 'West Indian sandalwood oil' is not a true sandalwood oil at all, as it is not derived from *S. album* but is the product of *Fusanus acuminatus* (*Santalum preissianum*). 'East African sandalwood oil'

is obtained from a species of *Osyris*, probably *Osyris tenuifolia*. The 'West Australian sandalwood oil', though derived from *Fusanus spicatus*, resembles the Indian oil very closely and in recent years has come to be regarded as a serious competitor of the true 'East Indian sandalwood oil' both in commercial and in medicinal uses.

CHEMISTRY.—The essential oil of sandalwood is distilled from small chips and raspings of the heartwood of the tree. The roots are also used and they are considered to yield a larger and a finer quality of oil. The yield of oil is estimated to be from 2.5 to 6 per cent. Owing to the close-grained structure of the wood and to the low volatility of the oil, distillation is extremely slow and consequently expensive. The oil is extremely viscid, of a light yellow colour and possesses a characteristic roseate and penetrating odour and a bitterish slightly acrid taste. It is soluble in from 3 to 6 volumes of 70 per cent. alcohol (by volume) at 20°C and has got the following characters: Specific gravity 0.973 to 0.985; optical rotation -14° to -21° ; refractive index 1.5040 to 1.5100; acid value 0.5 to 6; ester value 3 to 17; sesquiterpene alcohols (mostly santalol) 90 to 96 per cent.

The oil consists in the main of alcohols and their corresponding aldehydes. A body or mixture of isomers known as santalol is the principal constituent of the oil, occurring therein to the extent of 90 per cent. or more. It is a mixture of two isomers, known as α -santalol and β -santalol. The rest is composed of aldehydes and ketones, e.g., isovaleric aldehyde, santenone, santalone, etc.

ADULTERANTS.—The oil of commerce is frequently mixed with cedarwood oil to the extent of 10 per cent.; castor oil is also used as an adulterant in India. Both adulterants are easily detected by alteration in the physical characters, in the former by the decreased solubility in alcohol and in the latter by high ester value. Glyceryl acetate, benzyl alcohol, terpineol, etc., are some of the other adulterants met with.

MEDICINAL USES.—Both the sandalwood and the oil distilled from it have been used in the Hindu materia medica for many centuries. The wood is described in the Hindu medical works, as bitter, cooling, astringent and useful in biliousness, fever and thirst. An emulsion made of ground sandalwood is used as a cooling application to the skin in erysipelas, prurigo and sudamina. Ground up with water into a paste, it is commonly applied for local inflammations, and to the temples in fevers and hemicrania; it is used as an application in skin diseases to allay itching and inflammation. It has also been used as a diaphoretic and as an aphrodisiac. Dr. Henderson of Glasgow was the first to direct the attention of the European physicians to the use of the oil as a remedy for gonorrhoea and since his time it has been employed internally in many cases where copaiba and cubebs had previously failed. It is preferable to copaiba as it does not communicate an unpleasant odour to the urine nor does it so readily produce untoward effects.

ECONOMIC POSSIBILITIES.—In Mysore and in Coorg, the sandalwood trees belong to the State, while in the Coimbatore and Salem districts of Madras, although there is no absolute monopoly, the sandalwood forests are preserved and are strictly administered by the Forest Department. Before the British conquered Mysore from Tipoo Sultan, the rulers of that country had exercised a royal prerogative over the sandalwood tree and had imposed very stringent regulations against its exploitation without proper authority; in fact the tree, wherever it occurred, and whether artificially or naturally grown, was the property of the

rulers and not the occupier of the land. The reason for the exercise of all these regulations may be appreciated when we consider that a considerable amount of export trade existed in this wood for many years. As far back as 1825, there is mention of this trade in the 'coastal trade returns of India' as well as in the 'statistics of foreign trade'. An idea of the amount of revenue derived in the latter part of the last century may be estimated by a reference to the export figures of 1885-90. During the five years on an average about six lacs worth of sandalwood was bought from India by other countries. Mysore was the chief source and it was stated that the revenue derived from the sale of sandalwood formed one of the principal items of forest revenue in Mysore. Coming to more recent times, we find that before the War the annual production of the wood amounted to 2,500 to 3,000 tons of which 500 to 600 tons were consumed in the country and the remainder exported. This continued till May 1916 when the Bangalore sandalwood factory was opened. The Bangalore factory, from the Indian point of view, has been a decided success. A small initial output of 2,000 lb. a month has grown rapidly, and in 1921, 55,641 lb. of oil were exported as follows:

United Kingdom, 26,931 lb.; Japan, 12,336 lb.; France, 7,818 lb.; Straits Settlements, 1,986 lb.; Hongkong, 1,974 lb.; Anglo-Egyptian Sudan, 1,555 lb.; United States, 1,000 lb.; Other countries, 701 lb.; total, 54,301 lb.

In 1922 and 1923, the export figures were 1,21,602 and 1,49,464 lb. respectively. The starting of the Bangalore factory has given a new turn to the sandalwood oil trade in India. Considering that a ton of wood yields, on an average, about 105 to 110 lb. of the oil the foreign buyers are quickly appreciating the advantages of importing the oil and saving a large sum of money on the freight. The Mysore Government has also erected another factory at Mysore with a producing capacity of 20,000 lb. a month to meet the increased European demand. The whole of the output of sandalwood in Mysore, however, is not distilled in the State-owned factories. For fiscal reasons, some portion is distilled in New York. The returns for the year 1927-28 will give an idea as to the relative amounts distilled.

	Bangalore			Mysore			New York			Total		
	Tons.	cwt.	lb.	Tons.	cwt.	lb.	Tons.	cwt.	lb.	Tons.	cwt.	lb.
Quantity of Wood Distilled	796	2	96	849	18	0	375	0	0	2,021	0	96
Quantity of Oil Obtained	167,260 lb.						45,840 lb.			213,100 lb.		

Besides the oil distilled in the Mysore and the Bangalore factories which are owned by the State, a certain amount of oil is also prepared by private individuals. Much of this is used by the Indian perfumers who are said to require about 10,000 to 15,000 lb. per annum.

America is the most important sandalwood consuming country in the world at the present time and the oil is chiefly used there in the manufacture of toilet soaps. A study of the imports of sandalwood oil into America showed that the quantity decreased from about 50,000 lb. in 1924 to about 5,000 lb. in 1927 and

then rose again to about 12,000 lb. in 1928. It is difficult to find out why the supply showed this large decline. It is said that the amount of wood cut has been decreased by 70 per cent. because the forests are becoming depleted on account of indiscriminate felling. The shortage of sandalwood oil appears to be keenly felt in America as is evidenced by the fact that attempts are being made to tap other sources of the oil. The Australian oil prepared by distillation and rectification from the wood of *Eucarya spicata* a small tree growing in Western Australia has come to stay in the market. It has been shown by chemical analysis that the Australian oil contains about 95 per cent. of santalol. It does not possess the sweet odour of the Indian oil and its optical rotation differs markedly from that of the Indian oil. By fractional distillation of Australian sandalwood oil, however, a fraction is obtained which has an odour like that of sandalwood oil and this can be adjusted so as to come just within the British Pharmacopoeia limits. [The B. P. minimum is -13° ; Mysore oil has got a rotation of not less than -17° ; if the original Australian oil is fractionated and blended with oil from *S. lanceolatum* which has a rotation of about -40° , it can come just within B. P. limits].

It contains sesquiterpene alcohols known as 'fusanols', which after proper rectification yields an oil containing not less than 90 per cent. of free alcohols calculated as $C_{15}H_{24}O$. Both Indian and Australian sandalwood oils are used in perfumery. They are also employed as disinfectants for the uro-genital tract and as expectorants in bronchitis. Sandalwood oil to the tune of 13,259 gallons valued Rs. 13,86,216 and 9,695 gallons valued at Rs. 9,47,318 was exported from India in 1937-38 and 1938-39. During the same period 1,002 tons of raw sandalwood valued at Rs. 10,08,867 and 647 tons valued at Rs. 6,53,743 was exported from India. The essential oil Advisory Committee reported that out of a total world annual production of 112 tons, Mysore (India) produces 60 to 80 tons annually valued at Rs. 35,12,300.

The following report of the Essential oil Advisory Committee (1946) is of interest: "The manufacture of Sandalwood oil is conducted chiefly in Mysore and on a moderate scale at Kuppam, Mettur, Bombay, Kanauj and Karkal (S.K.). Most of the Sandalwood oil factories operate modern stills with steam and the quality of the Indian oil is approved all over the world. There are, however, some factories in Mangalore which still extract the oil by crude methods of distillation, but their production is negligible and they are thus of no importance. According to S. G. Sastry of the Government Sandalwood Oil Factory, Mysore, it was only during the last world war when the export of Sandalwood to Europe was cut off, that the Government of Mysore took the logical and correct course of manufacturing Sandalwood Oil in Mysore for export, rather than exporting the wood itself. The last world war thus gave an impetus to the Sandalwood Oil industry in India with the result that today India is not only self-sufficient for its requirements of Sandalwood Oil but has also developed a valuable export market for its oil. With the export of oil the export of sandalwood has considerably diminished. Though there is still a considerable export of the Mysore wood to

America where the oil is distilled for the American market, on account of the prohibitive duty imposed by the U. S. A. Government on the imported Sandalwood oil. We estimate the production of sandalwood oil in India at 100 tons per annum, the value of which at today's price of about Rs. 10 per lb. comes to Rs. 22.5 lakhs. With the development of the soap, toilet and perfumery industry and larger manufacture of pharmaceutical goods in India, there is every reason to believe that the manufacture of sandalwood oil will progress still further in the years to come. We notice that the British Pharmacopoeia has introduced a new specification providing for a minimum of 2 per cent. Santalyl Acetate. This addition may serve as a handicap to the sale of Indian Sandalwood oil where the B. P. specification is insisted upon and we should like to draw the attention of the Sandalwood oil manufacturers to this factor lest they may not be taken unawares".

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STROPHANTHUS (Apocynaceæ)

The official drug, *Strophanthus* B. P. consists of the dried ripe seeds of *S. kombe*, free from the awns. *S. kombe* is one of about thirty species of strophanthus found in Africa, where it occurs in the neighbourhood of the East African lakes (Nyanza, Tanganyika, and Nyassa) and the Shire River. The seeds are exported from Zomba in Nyassaland and the ports of Portuguese East Africa (Quillmane, Inhambane, and Chinde). The crystalline glycoside ouabain is obtained from the seeds of *S. gratus* or from the wood of *Acocanthera ouabaio* or *A. schimperi*.

The seeds derived from species of *Strophanthus* have long been used by the natives of East and West Africa for the preparation of arrow-poisons. One of these, known to the natives of the Shire River as kombi, was noted by Livingstone in 1861. Specimens of both the extract and the seeds were sent to England and in 1885 Fraser isolated strophanthin and recommended the use of the seeds in medicine. The plant is a liane which occurs both wild and cultivated. Each flower gives rise to two divergent follicles which, when ripe, are 20 to 35 cm. long and 2 to 2.5 cm. broad. While the British Pharmacopoeia admits only the seeds of *S. kombe*, those of two other species, namely, *S. hispidus* and *S. gratus*, are official in a number of foreign pharmacopoeias. The distinction of *Strophanthus* species by means of an alcoholic solution of furfurol and sulphuric acid has been suggested by Ekkert (1931) and Dumont and Thomson (1939). *S. kombe* is not found in India but there are several other species of strophanthus which are indigenous to the tropical regions of India and the Malayan Peninsula but so far little or no attempt has been made to find out the strophanthin content of these plants to see whether these might be utilized medicinally in place of the imported

variety. India imports annually large quantities of strophanthus seeds and its preparations. *S. wightianus* Wall., *S. wallichii* DC. and *S. dichotamus* are found growing wild in Assam, Orissa and South India. Handa studied the seeds of *S. wightianus* which is a climbing shrub growing wild in Malabar. The seeds contain 2.1 per cent. glycosides which have been provisionally named strophanthin-W. Preliminary studies indicate that tincture prepared from *S. wightianus* seeds compare favourably with the official tincture from *S. kombe* in biological activity on the blood pressure and the heart. The average potency of the tincture from *S. wightianus* is, however, considerably greater than that of official *S. kombe* tincture. Glycosides isolated from *S. wightianus* also show biological activity similar to that of Strophanthin-k. B. P. and international standard Ouabain.

CULTIVATION.—Some of the strophanthus plants are very beautiful and would adorn any garden. Cultivation of *S. kombe* is not beset with difficulties under conditions existing in India and it has been tried experimentally with a certain degree of success in the Botanical garden, Calcutta. An investigation into the possibilities of its cultivation in India would interest the drug manufacturers.

CONSTITUENTS.—Strophanthus contains about 8 to 10 per cent. of a mixture of glycosides known as strophanthin or k-strophanthin. The drug also contains about 30 per cent. of fixed oil, the nitrogenous bases trigonelline and choline, resin and mucilage. Strophanthus is an important medicine and is used as a cardiac tonic and also as a diuretic. It is intensely poisonous, being eight or nine times more so than digitalis. Its action on the heart is very similar to that of digitalis, but strophanthus has less effect on the nervous system. The so-called pure principles should not be given by mouth; strophanthin (amorphous), the only one recognized by the Pharmacopoeia, undergoes decomposition in the alimentary tract especially when given in pure form. Given by mouth it is often badly tolerated and strychnine is the best antidote to the toxic effects produced by it. Signs of an overdose are headache, sense of tightness in the chest and praecordium, marked slowing of pulse or coupling of the beats, marked rise in blood pressure, cardiac arrhythmia, insomnia, and nausea. These are best observed after intravenous use of the substance.

In cases of poisoning, the stomach should be emptied by an emetic or by stomach tube, dilute tannic acid solution being used to wash it. Stimulants, e.g., brandy or aromatic spirit of ammonia may be given.

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STRYCHNOS NUX-VOMICA Linn. (Loganiaceæ)**NUX VOMICA**

VERN.—Hind.—*Kuchla*; Beng.—*Kuchila*; Bomb.—*Kajra*; Tam.—*Yetti*; *Yettie-kottai*.

Nux vomica grows wild and plentifully throughout tropical India up to an altitude of 4,000 ft. above the sea level. It is not frequently met with in Bengal but grows abundantly in southern India, in the Madras Presidency, Cochin, Travancore and the Coromandal coast. It is also found in the forest of Gorakhpur, Bihar, Orissa, Konkan, North Kanara, Southern Mahratta country, Northern Circars the Deccan and Carnatic. A species of *Strychnos* trees, *S. nux-blanda* grows in Burma but medicinally it is of no importance as it does not contain either strychnine or brucine. Plantations have also been started in Orissa and neighbouring places. Though no definite figures are available as regards the area under cultivation, seeds are already being exported from Orissa and it is reported that a quantity is available for internal consumption. It may, therefore, be expected that the plantations are doing well.

Nux vomica is one of the most important drugs used in medicine. The powdered seeds and sometimes a decoction made from them have been used by the Hindu physicians in the treatment of dyspepsia and diseases of the nervous system. In indigenous medicine, *nux vomica* is used as a tonic, stimulant, febrifuge, and in the treatment of cutaneous diseases especially in ulcers infested with maggots. It has been stated that it is eaten habitually as an aphrodisiac in some parts of India. The powdered seeds mixed with food are also largely given as a tonic to horses. The whitish pulp of the fruit also contains strychnine, yet it is eaten by birds, monkeys, cows, and probably other animals as well; it is also stated to be eaten by man in certain localities. It has been observed that feeding upon the leaves of *nux vomica* imparts a bitterish taste (so characteristic of strychnine) to the milk of cows and the people of the locality attribute good digestibility and tonic properties to such milk, and not without reason. According to Gamble, the wood of this tree is not eaten by white ants. Watt mentions that the seeds are employed by country distillers, who sometimes add a small quantity to 'arrack' so as to render it more intoxicating. He also states that the seeds are used by the hill tribes of the Nilgiris as a fish poison. In the form of extracts and tincture and as alkaloids, *strychnos* is very commonly used in Western medicine.

CONSTITUENTS.—Strychnine, as stated before, is the most important alkaloid contained in this plant; besides this, there are present brucine and other constituents mentioned below. These compounds exist not only in the seed, which is the most important part of the plant, but also in the root, wood, bark, leaves, pulp, etc. The seeds may contain 1.53 to 3.24 per cent. of the total alkaloids of which about half is strychnine. They also contain the glycoside loganin. Recent work shows that, besides brucine and strychnine, the seeds contain other alkaloids, such as vomicine, α -colubrine, β -colubrine, pseudostrychnine, etc. The fruit pulp contains the glycoside loganin as well as brucine and strychnine. The leaves have been

found to contain the alkaloids brucine, strychnine, and strychnicine. The bark contains chiefly brucine and only traces of strychnine, but no strychnicine. The younger barks contain 3.1 per cent. and older 1.68 per cent. of brucine. The wood contains both brucine and strychnine. The roots (old) contain 0.99 per cent. of total alkaloids of which brucine forms 0.276 and strychnine 0.71 per cent. In spite of its wide-spread use and the abundance with which the drug grows in India, very little interest has been evinced in the utilisation of the raw materials locally. The foreign manufacturers, however, have not failed to appreciate the value of the Indian seeds and have systematically exported them in large quantities through their local agents. Cochin in southern India is the chief port of export, though not very insignificant amounts are sent out from such ports as Madras, Bombay and Calcutta. The total exports from India approximate about 45,000 to 50,000 cwt. annually, valued at about Rs. 3,00,000, almost entirely to Great Britain. Strychnine is now being manufactured in India (Calcutta) on a large scale and as much as 15,000 lb. are being manufactured and exported to Australia for destroying rabbits. The greatest difficulty in the way of the Calcutta manufacturers appears to be the enormously high price for the seeds they have to pay on account of the high transportation charges by railway (price in Calcutta is Rs. 6 per md. of 82 lb.; price in the Orissa ports—Re. 1-4-0 per md. of 105 lb.). The European manufacturers on the other hand, get the same article landed there at a much less cost as the shipping companies carry this commodity as ballast at very low freight. Even at the present prices, large quantities have lately been imported into Australia to kill rodents which abound there. The trade in nux vomica seeds is practically the monopoly of India and Ceylon. Though the alkaloids occur in numerous species of *Strychnos*, they are not present in sufficient amounts to serve as commercial sources. *S. colubrina* Linn. found in south India containing higher percentage of strychnine is also another source for the alkaloids. The other competitor is *S. ignatii*, a climbing plant of the Philippine islands from the fruits of which are derived the 'St. Ignatius' beans. These beans contain both strychnine and brucine in fairly large amounts and have been successfully used in extraction of alkaloids on a commercial scale. The seeds contain about 2.5 to 3.0 per cent. of total alkaloids of which about 46 to 62 per cent. is strychnine. The seeds are mainly used for the preparation of strychnine and brucine. The demand for strychnine, however, is increasing steadily as it is being employed largely as an insecticide and as an animal poison. If attention is paid to the proper cultivation of the trees and better methods of collection of the seeds than is at present in vogue, the country will gain appreciably.

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SWERTIA CHIRATA Buch-Ham. (Gentianaceæ)**CHIRETTA**

VERN.—Sans.—*Kiratá-tiktá*, *Bhunimba*; Hind.—*Charayatah*; Beng.—*Chireta*; Bomb.—*Chiraita*, *Kiraita*; Tam.—*Nila-vémbu*.

The herb grows abundantly in the temperate Himalayas from Kashmir to Bhutan and Khasia Range between 4,000 to 10,000 ft. above the sea level. It has long been used by the Hindu physicians as a bitter tonic, stomachic, febrifuge and anthelmintic. An infusion of the drug is generally employed, but it forms part of many compound preparations. The Mohammedan physicians also use it extensively. The European practitioners in India in the early days appreciated the value of chiretta and very frequently prescribed it in place of the official gentian. The report of Fleming (quoted in Watt's *Dictionary of the Economic Products of India*) will bear testimony to the high reputation the drug enjoyed in those days. According to him chiretta possesses "all the stomachic, tonic, febrifuge and anti-diarrhoeic virtues which are ascribed to gentian and in a greater degree than they are generally found in it in the state in which it comes to us from Europe." Experiments carried out in India regarding the chemical composition of *S. chirata* also show that it can effectively replace the gentian of the Pharmacopoeia. The common variety of chiretta as obtained from the Indian bazar was assayed for the contents of its bitter principle by the method suggested by Zellner.

By this method the percentage of bitter principle was found to vary from 1.42 to 1.52. Gathercol and Wirth report that chiratta contains a bitter glycoside chiratin, which is precipitated by tannin and yields on hydrolysis two bitter principles, ophelic acid and chiratogenin, the latter being insoluble in water. Ophelic acid is a brown hygroscopic substance which is readily soluble in water and in alcohol. The drug also contains resin, tannin and 4 to 8 per cent. of ash.

There are several spurious kinds of chiretta in the market as well. *S. angustifolia*, *S. decussata*, *S. corymbosa* and *S. pulchella* are used in the indigenous medicine in southern India. Some of these are not bitter at all and are, therefore, devoid of therapeutic activity. True chiretta, viz., *S. chirata* has now been recognised in the British and the United States Pharmacopoeias. It is obtainable in the Indian bazars in large quantities. Japanese Chiretta, derived from *S. chinensis* Franchet, is derived from a much smaller plant; it yields more alcoholic extract and is more bitter than *S. chirata*. It contains a crystalline glycoside, swertiamarin yielding by hydrolysis with emulsin erythrocentaurin and glucose; it also contains crystalline tasteless swertic acid. Chiratta is a bitter tonic. It is also used in dyspepsia in the debility of convalescence and generally in cases in which corroborant measures are indicated. It may be given in powder, infusion, tincture or fluid extract. It is used as tonic to gouty persons.

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- (2) Wallis, T. E., 1946, *Text Book of Pharmacognosy*, 278; (3) Gathercoal, E. N. and Wirth, E. H., 1936, *Pharmacognosy*, 573; (4) Mukerji, B., 1953, *Indian Pharmaceutical Codex*.

URGINEA INDICA Kunth. (Liliaceæ)

INDIAN SQUILL

VERN.—Sans.—*Vana-palāndam*, *Kolakanda*; Hindi. and Beng.—*Kānde*, *Jangli-piyaz*; Punj.—*Phaphor*, *Kachwassal*; Bomb.—*Jangli kanda*; Tam.—*Nari-vengāyam*.

SCILLA INDICA Roxb. (Liliaceæ)

VERN.—Hind. and Beng.—*Suphadic-khus*; Bomb.—*Bhuikanda*; Tam.—*Shirunari-vengayam*.

It is known in commerce as white squill. The plant grows on sandy soil on the Mediterranean coasts of Spain, France, Italy, Sicily, Malta, Greece, Algiers and Morocco. The bulbs are collected in August, a month in which the plant is without aerial leaves. After removing the dry, outer, scales the bulbs are cut transversely into thin slices. These are dried in the sun or by stove heat, when they lose about 80 per cent. of their weight. The dried slices are packed in bags (containing about 1 cwt.) or in barrels. Squill was well-known to the early Greek physicians and to the Egyptians. A vinegar of squills was known to Dioskurides and an oxymel of squills to the Arabian physicians. Two varieties of squill are recognised: (1) White squill (Italian or female squill), a variety with whitish or yellowish outer scales cultivated in Malta, Sicily and Italy; and (2) red squill (Spanish squill or male squill), a variety with reddish scales cultivated in Algiers.

The bulbs and also the preparations made from them were and are still imported into India from countries bordering on the Mediterranean and a high price has to be paid for them. In India, several species of squill grow abundantly which have got properties almost identical with the official squills. *S. indica* Baker grows frequently in the sandy places especially near the sea, in the Deccan peninsula, from the Concan and Nagpur southwards. *S. hohenackeri*, Fisch et Mey, is a closely allied species met with in the Punjab. The bulbs are whitish brown in colour, scaly, about the size of a nutmeg and composed of very smooth and fleshy scales which are so imbricated that they may be mistaken for coats if not carefully examined. They are roundish and ovate in shape, sometimes slightly compressed on the sides. *U. indica* Kunth., grows in the sandy soil, especially near the sea throughout India. It also grows in the drier hills of the lower Himalayas and on the Salt Range in the Punjab and N. W. F. Province at an altitude of 2,000 ft. The bulbs are about the size of a lime and are tunicated. The outer coats are inert. The squill sold in the Indian bazars is a mixture of these two varieties. The whole bulbs are usually sold in an unsliced state, in ordinary druggists' shops, but of late sliced squills are also being supplied to the large manufactures from Chittagong, Bombay and Jaunpur (U. P.). The two kinds have the same action and can be distinguished by the fact that *Urginea* bulbs are tunicated, while the *Scilla* bulbs are imbricated. The bulbs, though smaller than the imported variety are equally nauseous and bitter. In preparing squills for the market particular attention has to be paid to proper drying of the sliced bulbs, otherwise they may get mouldy in the course of transport and may lose their activity.

A great deal of attention has lately been paid to the expectorant, cardiac stimulant and diuretic properties of scilla. Although a useful and potent drug, on account of its irritable effects on the gastro-intestinal tract it has not been possible to use it to any large extent in therapeutics as a cardiac tonic. Efforts have, therefore, been made of late years to isolate its active principles and to see if it is possible to separate them from irritating substances contained in the bulbs. Two substances have been isolated (1) an apparently pure crystalline glycoside named scillaren A, and (2) an amorphous complex constituent, probably a mixture of two glycosides which has been given the name of scillaren B. The latter substance is easily soluble in water while the former is practically insoluble. Both experimental and clinical experience with the drug has shown that the action of scillaren closely resembles strophanthin and it was also said that like the latter substance it suffers from the disadvantage that it cannot be given by the mouth. Stoll and Renz have obtained a new crystalline cardiac glycoside scillaroside from the red variety of *S. maritima* which has been extensively used as a rat poison. From two South African species of squill *U. rubella* and *U. hurki*, Louw has reported the isolation of rubellin and transvaalin respectively. Recently, Sheshadri and Subramanian observed that the Indian squill, *U. indica* and *S. indica* as available in the market in the form of dry slices yields two glycosidal fractions: (1) The water insoluble (A) is found to be a mixture of glycosides which on hydrolysis with acid yields, besides glucose and rhamnose, Scillaridin A as predominantly the major component a new aglucone melting at 265–67°C. and having the molecular formula $C_{26}H_{32}O_4$. Scillaren A may be considered to be the major glycoside of fraction (A), and (2) the water soluble part (B) resembling scillaren B gives on hydrolysis a crystalline aglucone, m.p. 227–30°C. and glucose. De (1927) showed that scillaren exerts a digitalis-like action on the heart and that its irritant action on the alimentary canal is slight and that it is absorbed from the alimentary tract. Stehle, Ross and Dreyer (1931) have shown that scillaren B produced a rise of blood pressure owing to its vaso-constrictor action in animals, the amplitude of ventricular beats is increased and that the cardiac output is improved.

For many years the Indian varieties have been used as a substitute for the official varieties by the Government Medical Store Depot in Bombay for the manufacture of galenicals and the results obtained clinically have been quite satisfactory. The Indian variety was even made official in the British Pharmacopoeia in 1914. *U. indica* is said to be cheaper than *U. maritima* and, if its cultivation and the method of harvesting are improved and it is grown on a large scale, it will successfully compete with the Mediterranean variety in the European market. Some of the drug manufacturers in Calcutta are using the combined bulbs of *S. indica* and *U. indica* obtained from the Chittagong hill tracts for the preparation of tinctures, etc., and a large trade in this drug has developed in that part. In the following table we have summarised our results of the biological assay of tinctures of scilla made from the imported and Indian varieties. The assays were carried out by Chopra and De's modification of Hatcher's cat method and gave good cardiac response.

	No. of samples assayed	Up to B.P. standard	Below B.P. standard	Stronger than B.P. standard
<i>U. indica</i> and <i>S. indica</i> from Chittagong	73	64 (87.6%)	8 (10.96%)	1 (1.44%)
<i>U. Scilla</i> from the Mediterranean coast (imported)	28	19 (67.9%)	3 (10.7%)	6 (21.4%)

A perusal of the above table will show that the Indian squills are in no way inferior to the imported varieties of *U. scilla* and *U. maritima*.

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VALERIANA WALLICHII DC. (Valerianaceæ)

INDIAN VALERIAN

VERN.—Sans.—*Tagara*; Hind. and Beng.—*Tagar*, *Nahani*, *Shumeo*, *Asarün*;
Bomb.—*Tagar-ganthoda*.

Valerian is a very old remedy. It was known to the Greek physician Dioscorides under the name 'Phu' and 'Phu Germanicum' was the name used by Fuchs for it in 1542. In the middle ages it was used as a perfume and as a spice and its medicinal name 'Poor man's treacle' implied something very precious. The name valerian was used by Haller late in the 17th century and also by the English botanists. It was known from very ancient times in Germany, Russia, Greece and Asia-minor. There are two varieties of English valerian, *V. officinalis* var. *mikanii* (Syme) and var. *sambucifolia* (Mik.); the latter has broader oblong lanceolate leaves, the former is more robust yielding a larger and more odorous root. They occur commonly in Derbyshire and are cultivated to a limited extent in that county and in other parts of England. The root used in the British Pharmacopoeia is dull brown and yields 8 to 10 per cent. ash rich in manganese. The French-Belgian root is paler straw coloured and is at the present time the chief commercial source. It is scientifically cultivated in Belgium and also in the Department Du Nord in France, but the wild plant, which grows on the Ardennes and Vosges Mountains on moderately dry soil, is said to be much more active. A variety used to be grown in Scotland and in Derbyshire and was in great demand in America but the industry no longer exists. Skalinska (1947) has shown that polyploidy occurs in *Valerian officinalis* and that these are diploid, tetraploid and octaploid types. English cultivated valerian is usually octaploid and central European tetraploid.

The demand for valerian all over the world appears to have increased of late years. In 1918 after the world war, the price of valerian went up to at least 3 times its usual price probably on account of its extensive use in shell shock cases.

Although it has been used in the treatment of hysteria and nervous troubles of women for ages, valerian has gained an added importance after recent researches on its properties and actions in neurosis and epilepsy. In view of these facts, the sources of valerian in India were studied in detail. Most of the valerian met with in commerce in India is *V. wallichii* rhizome and is imported from Afghanistan and Western Himalayas. A number of species of Valerian grow wild in the temperate Himalayas. *V. hardwickii* Wall. and *V. wallichii* DC. both grow abundantly in the mountain ranges extending from Kashmir to Bhutan at altitudes ranging from 4,000 to 12,000 ft. above the sea level. *V. officinalis* the official root of the Pharmacopoeia, also grows in the north of Kashmir at Sonamarg at a height of 8,000 to 9,000 ft. but is not nearly so common as the other varieties. The antispasmodic and stimulant properties of this plant are well-known in the indigenous medicine and have been described in the books of Hindu medicine.

CULTIVATION.—The plants grow well in all ordinary soils but prefer a rich and rather heavy loam which is well supplied with moisture. It is often found to flourish well in damp, shady places. Some drought resistant forms also occur on chalk and limestone hills. The plant may be propagated easily by dividing the old roots, either in the fall or in the spring, and setting the divisions about a foot apart in rows 2 to 3 ft. apart. If the divisions are set very early in the fall in time to become well established before frost, good crop may be harvested the following autumn. Summer cultivation consists of weeding the beds and taking off all the flower stalks to promote the formation of numerous basal leaves and, consequently larger root stock. The plants may be propagated also from the seeds. Seed is usually sown on a seedbed and the seedlings transplanted to their permanent position 7-8 in. apart, in rows 12 in. apart. Early in the spring the seedlings may be transplanted to the field and set at the same distances apart as the divisions of the root. Growth of the plants are favoured by a liberal application of farmyard manure which should be well worked into the soil before the plants are set out. A low ridge of soil is usually drawn up round the base of the plants to promote the formation of a large rhizome.

The root of the plants propagated by division may be collected in the fall of the first year's growth although the yield generally is small. The seedling plants do not reach a suitable size before the end of the second growing season. In September or October, the tops are levelled to the ground with a scythe and the rhizomes are dug up. Washing is done by placing the roots in baskets or perforated boxes which are suspended in running water. The rhizomes are occasionally stirred with a rake to hasten the cleansing and when clean are kiln dried. The large rhizomes are cut into halves and pieces to facilitate drying. The drying should be very thorough. The Swedish roots collected in spring is reported to yield a better percentage of oil than these collected in autumn.

Valerian is prized in medicine on account of the presence in the roots of a valuable essential oil. An average specimen yields 0.5 to 0.9 per cent. of the oil but the yield varies with the locality and the season of collection. Dutch roots are said to yield about 1 per cent. of the oil while the Swedish give a still higher

percentage. The fresh roots collected in the spring gave as much as 2.12 per cent. volatile oil, but a lower yield was obtained from the autumn-gathered rhizome. The Indian valerian root, obtained from the *V. wallichii*, has been analysed by Bullock. He reported (1925-26) that the drug contains about 0.3 to 1.0 per cent. of volatile oil containing esters of iso-valerianic and formic acid. Specimens of the root from Kashmir were also examined at the Calcutta School of Tropical Medicine and practically the same results were obtained. This is probably due to the fact that the rhizomes were not collected at the proper time and were not properly stored. Kapoor (1953) reported that *Valerian wallichii* collected from Chamba contained 1.2 per cent. essential oil. Most of the specimens received for analysis at the School were very dry and much of the essential oil appeared to have been lost. By careful collection and storage, there is no doubt that the quality could be improved, as has been amply shown by foreign investigators. Indian valerian was made official in B.P. 1914 and in the B.P. 1932 4th Addendum. In India and the Eastern Colonies, Indian valerian is used as carminative and antispasmodic. An ammoniated tincture of valerian possesses the same properties as the valerian officinalis.

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ZINGIBER OFFICINALE Rosc. (Zingiberaceæ)

GINGER

VERN.—Beng.—*Ada*; Bomb.—*Adu*; Hind.—*Ada*, *Adrak*; Mar.—*Ale*; Sans.—*Adrakam*; Tel.—*Allamu*, *Ardrakamu*, *Sonti*, *Sringaberamu*; Tam.—*Allam*, *Attiradam*, *Maruppu*, *Sangai*, *Sigaram*, *Sukku*, *Sundi*, *Ubugallam*; Uriya.—*Ardroka*, *Oda*.

The history of ginger is interesting. Ginger appears to have been used as a spice and a medicine from early times by the Chinese and the Indians, there being numerous references to it in Chinese Medical treatises and in Sanskrit literature. The ancient Greeks and Romans appear to have regarded the spice as being of Arabian origin, owing to the fact that they obtained supplies of it by way of the Red Sea. The use of ginger as a condiment and in medicine is so wide that it scarcely needs any description. It was at one time much employed for spicing beer, and the modern equivalent, ginger beer, is highly esteemed to-day as a beneficial cordial in cold weather. The taste of ginger being aromatic and pleasantly pungent, it finds wide employment as a spice in the preparation of dishes of a most diverse character, varying from curries to ginger bread. By virtue of its action as a carminative and stimulant to the gastro-intestinal tract, ginger plays a very useful part in pharmacy. It is much in vogue as a household remedy for flatulence, and there are numerous preparations containing ginger included in the British and other Pharmacopoeias.

Z. officinale is a herbaceous perennial, producing leafy shoots which attain a height of about 1 to 3 ft. After the flowers have disappeared and the stems have withered, ginger is ripe for collection. The rhizomes are dug up and prepared for the market in different ways.

The following details of the cultivation and preparation of Jamaica ginger are given by Harris: "The virgin soil of the forest produces the best ginger, but a well-drained, clayey loam is suitable, and the rainfall must be abundant, 80 in. and upwards per annum, with a temperate climate. Pieces of rhizomes, each containing an 'eye' or bud, are planted a few inches below the surface in holes or trenches in March or April. 'Plant' ginger is harvested during December and January, but 'ratoons' may be gathered from March to December. The rhizomes are ready for digging when the stems wither, which takes place soon after flowering. When the rhizomes are dug, they are peeled with a knife specially made for the purpose. This operation requires much care and experience. As a rule, experienced operators peel between the 'fingers' of the rhizomes, the other portions being peeled by less experienced workers. This work is always done by women and children. As fast as peeled the rhizomes are thrown into water and washed, the purer the water and the more freely it is used the whiter will be the product. The ginger peeled during the day is allowed to remain in the water overnight. After washing, the rhizomes are spread out on barbecues or on mats in the sun early in the morning. They are turned during the day, and are taken under cover during cloudy or rainy weather and at night, as if allowed to get damp they become mouldy. The drying process occupies five to six days, and during this period the ginger loses about 70 per cent. of its weight. After drying it is bleached by washing, and again dried for two days, when it is ready for shipping".

Gingers are also found in commerce from which little or no cork has been removed. These 'coated' or 'unscraped' gingers are sometimes whitened by means of chemicals such as sulphurous acid or chlorine, or are dusted with calcium carbonate or sulphate to improve their appearance. Gingers are also sometimes limed both in continent and in London to minimise insect attack. The Jamaica drug, however, is sun-bleached, but, heavily limed samples would yield more than the officially permitted percentage of ash. Dutta and Mukerji have observed, that, in India the plant is cultivated very easily. Propagation is effected by division of the rhizomes in spring. These should be potted in fibrous loam to which one third of well decomposed cow or sheep-manure has been added. Water should be given sparingly until the shoots have well developed when they should have an abundance. They are also benefitted by an occasional watering with weak liquid manure water. Towards the end of summer the shoots will begin to mature, when the water supply should be diminished and as soon as plants are ripened off, the pots may be stored either under the green house stages or in some other convenient place, when they should be kept almost dry for the winter.

... Several other varieties of dried ginger are recognised, according to the country of origin and the methods of preparing it. 'Plantation ginger' consists of rhizomes

formed in winter time by small portions of rhizome (each containing an 'eye') planted in the previous spring. 'Ratoon ginger' consists of new rhizomes formed by allowing portions of the first crop of rhizome to remain in the ground when the plantation ginger is harvested. The ratoon ginger is of inferior quality, the rhizomes being smallest and more fibrous than those of plantation ginger. In India, ginger is cultivated in many places, and process of cultivation is very similar to that followed in Jamaica. Cochin ginger takes the highest rank among Indian gingers, but the districts of Rungpur, Midnapore and Hooghly in Bengal, Surat and Thana in Bombay and Kumaon in the Uttar Pradesh are also noted for production of good ginger.

CHEMICAL COMPOSITION.—Ginger contains from 0.25 to 3 per cent. of a volatile oil of light yellow colour having a characteristic odour. Jamaican variety yields about 1 per cent., African from 2 to 3 per cent. and the Indian about 3.5 per cent. Oil of ginger, to which the drug mainly owes its aroma, contains terpenes (*d*-camphene and β -phellandrene), a sesquiterpene (zingiberene), cineole, citral and borneol. The pungency of ginger is due to the "oleo-resin", gingerol, an oily liquid consisting of homologous phenols. The pungency of gingerol is destroyed by boiling with 2 per cent. potassium hydroxide. Boiling with baryta water decomposes it with formation of a phenolic ketone called zingerone and aliphatic aldehydes (mainly normal heptaldehyde). Zingerone like gingerol is pungent but possesses in addition a sweet odour. It is a crystalline substance, sparingly soluble in water, freely soluble in dilute alkalis and in most organic solvents. Its pungency is destroyed by prolonged contact with 5 per cent. sodium hydroxide. Zingerone is related to vanillin and has been prepared from it synthetically. Ginger also contains resinous matter, starch and mucilage. It yields about 3 to 5 per cent. of ash, and 12 to 15 per cent. of water-soluble extractive.

ECONOMIC ASPECTS.—The Jamaican ginger is the most highly esteemed variety of ginger in the market and commands the maximum price. Ginger growing in India has also a considerable market and with more attention should get wider recognition. Jamaican ginger is grown in sandy loam where good irrigation is possible in case the rainfall is unsatisfactory. The yield per acre in Jamaica is said to be on an average from 1,000 to 1,500 lb. of dried ginger and as much as 2,000 lb. is sometimes obtained. In Bengal, the yield is from 1,000 to 1,500 lb., in the Punjab 2,100 lb. and in Travancore 2,500 lb. It will appear from the figures quoted above that as regards the quantity of production India stands on an equal footing with Jamaica, and with scientific cultivation it may be confidently hoped that the yield will increase.

There are several varieties of ginger in commerce and the characters of the commercial varieties are given below:

1. **African Ginger:** Rhizomes with cork partly removed on the flattened sides, the surface areas without cork smooth and of a light brown colour; those with cork greyish brown and reticulately or longitudinally wrinkled, fracture short or short fibrous; internally light yellow to brown with yellow oil cells and reddish brown resin cells; odour strongly aromatic, taste aromatic and strongly pungent.

2. **Cochin Ginger:** On the flattened sides of the rhizomes most or all of the corky layer removed. The outer surface is externally light brown to yellowish grey in colour; internally weak to medium yellow with numerous

yellowish oil cells and brownish red to black resin cells; odour aromatic; taste strongly aromatic and pungent; fracture short and mealy.

3. Calcutta Ginger (Race Ginger): The rhizomes resemble African Ginger, the branches being usually larger, and with a considerable portion of shrivelled pieces; externally greyish brown to greyish blue; fracture short and brittle, mealy or horny internally light yellow or light brownish yellow with many yellowish oil cells and yellowish brown resin cells; odour aromatic; taste starchy, strongly aromatic and pungent.

4. Calicut Ginger (Lemon Ginger): Rhizomes resembling African Ginger, but more of the peridermis usually removed; externally dark yellow, orange or reddish brown; fracture brittle and uneven, mealy; internally light yellow or brownish yellow with large stele and numerous yellow oil and resin cells; odour aromatic; taste strongly aromatic and pungent.

5. Japanese Ginger (From *Zingiber mioga* Rosc.): Rhizomes usually with a thin coating of lime; externally nearly smooth and of a whitish colour; fracture, short, brittle and very mealy; internally yellowish white to light brown with numerous brownish red resin cells; odour aromatic; taste strongly aromatic and pungent.

The United Kingdom was the best market for Indian ginger for a long time as will be evident from the following statements of export of ginger to the United Kingdom in 1912 before the First World War:

Exports from Different Countries			Value in £
	Quantity in cwt.		
India	65,544		107,464
Jamaica	20,996		37,180
Sierra Leone (Africa) ..	21,860		33,280

The advantageous position of India in this business seems to be seriously attacked by the Jamaican and the African products during the past. Thus in 1927, Jamaica exported over 1,200 tons (24,000 cwt.) of the spice. Sierra Leone (Africa) is also showing definite signs of progress, the export figure showing an amount of 1,400 tons (28,000 cwt.). The export of Indian ginger has definitely gone down, as will be seen from the figures to the end of March 31st, 1929 which stood at 2,300 tons (46,000 cwt.). We should not, however, forget that in India very large quantities of ginger are used in the preparation of curries and for medicinal purposes and consequently the actual amount produced may be considerably in excess of these figures if local consumption is taken into consideration.

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PART III

DRUGS USED IN THE INDIGENOUS MEDICINE

SECTION I

DRUGS OF VEGETABLE ORIGIN

In the section dealing with the evolution of the Indian indigenous drugs in Part I, it has been pointed out that they include the drugs used in the ancient Hindu medicine and as well as those used in the Tibbi or the Mohammedan medicine. Both these systems have ministered to the needs of the population of this country for many centuries. Besides these, the drugs used in the Western medicine, which have been introduced into India and which have become completely naturalised, are also included. This last group of drugs has been dealt with in detail in Part II, and it will be observed that in that case particular stress has been laid on their economic aspects as their medical aspects are well-known. In Part III it is proposed to deal with a number of well-known drugs commonly used by the indigenous practitioners which have been worked out on scientific lines. Those drugs which have not been examined by modern methods of research have been left out and for these the reader is referred to such works as Dymock's 'Pharmacographia Indica', Watt's 'Dictionary of the Economic Products of India', 'Wealth of India' and other literature mentioned in Parts I and IV.

It is fully realised that Part III of the book is very incomplete as we have only been able to deal with a small number of drugs out of hundreds that are used. It is hoped, however, that as research on these drugs progresses and more material is available, it will be possible gradually to expand this section of the book. A comprehensive list of drugs given in Part IV will give an idea as to the enormous possibilities of such expansion.

Many of the drugs dealt with in the following pages have been investigated by workers in India. So far as possible every aspect of the use of the drug in the treatment of disease both in the indigenous and Western medicine has been discussed. Chemistry of the drug has been given so far as it concerns its pharmacological action. Economic aspects so far as the cultivation and the scope of its exploitation in commerce has been briefly discussed.

ABROMA AUGUSTA Linn. (Sterculiaceæ)

DEVIL'S COTTON

VERN.—*Gunakhiakarai*; Beng.—*Olatkambol*, *Ulatkambal*, *Ulutkambal*; Bomb.—*Olatkambol*; Eng.—*Devil's cotton*; Hind.—*Kumal*, *Ulatkambal*, *Sanukapashi*; Nepal.—*Sanukapasi*; Tam.—*Sivapputtutti*.

A. augusta grows wild throughout the hotter parts of India from the Uttar Pradesh to Sikkim, Khasia Hills and Assam. It is also cultivated in gardens for

its showy, deep-scarlet flowers. The root of the tree is characterised by a thick fibrous brown bark and both the root and the root bark are used in medicine as an emmenagogue in menstrual disorders. The fresh viscid sap is said to be more efficacious and is used in dysmenorrhoea in doses of 30 grains a day. Thornton considered it to be useful in the congestive and neuralgic varieties of dysmenorrhoea and thought that it regulated the menstrual flow and acted as an uterine tonic. It is a very popular medicine in the indigenous systems.

CHEMICAL COMPOSITION.—Little or no previous work has been done on this drug. The material used by the author consisted of the root secured locally. To test for the presence of alkaloids, the powdered root was extracted with Prollius' liquid. The extract taken up in dilute HCl gave all the reactions for alkaloids. The amount, however, was less than 0.01 per cent. The petroleum ether extract showed the presence of a fixed oil and a little resinous matter; the ethereal solution gave further amounts of resin; the alcoholic extract showed the presence of an alkaloid soluble in chloroform (about 0.01 per cent.) and also some water-soluble bases in larger amounts, some carbohydrates, resins and phlobaphenes. The cold aqueous extract showed the presence of a fairly large amount of mucilaginous matter. The hot aqueous extract did not show the presence of any inulin-like substance. As the water-soluble bases were found to be predominant, the method used by Henry for the isolation of betaine, choline and other water-soluble bases was applied to a large quantity of the powdered root. The yield of the total bases was nearly 0.1 per cent.

The root, thus, has the following constituents: (1) A fixed oil, (2) resins, (3) an alkaloid in minute quantity (0.01 per cent.), (4) water-soluble bases.

PHARMACOLOGICAL ACTION AND THERAPEUTIC USES.—The alkaloid and different fractions obtained during the course of analysis including the water-soluble bases were passed through pharmacological tests, but no remarkable activity was manifested on the gastro-intestinal tract, circulation, respiration, etc., nor was there any marked effect on the uterus, whether virgin or pregnant, isolated or *in situ*. In the absence of any sign of physiological activity, clinical trials were not carried out. S. Sirkar of Dacca (unpublished) found in an aqueous alcoholic extract of the plant, fairly large quantities of magnesium salts in combination with hydroxy acids, besides gums, resins and other organic residues. In view of the fact that magnesium salts of some hydroxy acids are valuable as styptics, he thinks that the utility of *A. augusta* in uterine haemorrhages might be due to the presence of the magnesium salts. Further work is necessary to determine the true nature of the active principles.

References:—

(1) Henry, 1925, *J. Amer. Chem. Soc.*, 2721; (2) Chopra and Ghosh, 1929, *Ind. Jour. Med. Res.*, 17, 377.

ABRUS PRECATORIUS Linn. (Leguminosæ)

INDIAN OR WILD LIQUORICE ROOT

VERN.—Arab.—*Aainuddik*; Assam.—*Laturvani*; Beng.—*Chunhati, Gunch, Kunch*; Bomb.—*Ghungchi, Gunja*; Eng.—*Indian liquorice, Jequirity, Paternoster pea, Rosary pea, Weather plant, Wild liquorice*; Guj.—*Chanoti, Gunja*; Mar.—*Chanoti, Gunchi, Gunja, Kunch*; Mal.—*Atimadhuram, Irattimadhuram, Kakani, Klitakkam, Kunni, Kunnikkuru, Madhukam,*

Shekkunni; Pers.—*Chashmekharush*, *Chasmkuros*; Punj.—*Labri*, *Ratak*; Sans.—*Angaravallari*, *Aruna*, *Bhilabhushana*, *Chakrashalya*, *Chataki*, *Chudala*, *Chudamani*, *Dhvankshanakha*, *Durmogha*, *Gunja*, *Gunjika*, *Kakashimbi*, *Kakatundika*, *Kakavallari*, *Kakini*, *Kamboji*, *Kanchi*, *Kanichi*, *Krishnachudika*, *Saumya*, *Shvetagunja*, *Shvettabija*, *Shvetochchata*, *Shyamalachuda*, *Tulabija*; Tam.—*Adisamyyai*, *Adingam*, *Atti*, *Kandam*, *Kunjam*, *Kunjuram*, *Kunrimani*, *Maduragam*, *Sittilai*; Tel.—*Atimadhuramu*, *Gurija*, *Gurivenda*, *Guruginja*, *Raktika*, *Sinnaguruginja*; Urdu.—*Ghunchi*.

It is a beautiful woody climber, found all through the plains of India and Ceylon and also along the Himalaya ascending to an altitude of 3,000 ft. It flowers in August and September and the pods ripen by the end of the cold season. The seeds are slightly smaller than ordinary peas and are usually of a bright scarlet colour with a black spot at one end though white seeds are also met with. The root is woody, tortuous and much branched. Mohammedan writers describe the seeds under the name 'ain-ed-dik' (cock's eye) and state that they are hot, dry, tonic and aphrodisiac. The small, shining red seeds are used by goldsmiths as weights, each weighing about 1.75 gr. They are also used domestically as ornaments and decorations for boxes, etc. The seeds are poisonous and are used by sweepers and other lower class people for criminally poisoning cattle to obtain their skins. The seeds are ground into a paste and made into needles which are inserted under the skin of the animal. Similar needles have also been used to produce criminal abortion. The practice, however, is gradually disappearing.

CHEMICAL COMPOSITION.—A watery extract of the bruised seeds of *A. precatorius*, when dropped into the eyes, produces an inflammation of the conjunctiva. This irritant action was thought to be due to a special bacillus called *Jequirity bacillus*, which grows in the infusion of the seeds. Later observations, however, show that the toxic and irritant actions were due to principle called *abrin* which is of the nature of a toxalbumin. Besides abrine, the seeds also contain poisonous proteins, a fat-splitting enzyme, abruccic acid, haemagglutinin and a quantity of urease. The shell of the seeds contains a red colouring matter. The leaves of the white seeded variety are sometimes chewed separately or with cubebs and sugar, as a cure for hoarseness and aphthous stomatitis. They contain glycyrrhizin and abrine.

The roots and leaves contain glycyrrhizin the active principle of liquorice. Dongen estimated the amount in roots as 1.25 per cent. Recently Ghatak (1932) isolated from the seeds an alkaloid abrine, $C_{12}H_{14}O_2N_2$, a glycoside abralin, $C_{13}H_{14}O_4$, and a small quantity of fatty oil (saponification value 192, iodine value 95). He also established that the colouring matter of the seed coat abranin is a monoglycosidic anthraquinone.

PHARMACOLOGICAL ACTION.—Abrine is an intensely poisonous albumin. Doses of about 1/1000 mg. to 1/2000 mg. per kilo. body weight injected subcutaneously are said to be poisonous. An infusion of the bruised seeds when applied to the conjunctiva may cause fatal poisoning due to absorption of the toxic abrine through the conjunctiva. Abrine contains two fractions—a globulin and an albumose—the former being more powerful. It is a very powerful irritant and produces oedema and ecchymosis at the site of inoculation. It has little or no irritant action on the mouth and throat and is digested and rendered harmless in the stomach. One interesting phenomenon about abrine is that, when it is injected into animals in infinitesimal doses, the animal rapidly acquires immunity to the action of the

poison. Simpson and co-workers (1932) found that when the seeds were administered in large doses of from 0.5 oz. upward, they were extremely toxic to horses but were comparatively harmless to dogs, goats and cattle. When given to horses in gradually increasing doses tolerance to the poison was developed.

THERAPEUTIC USES.—This plant has been used for medicinal purposes by the Hindus from very early times and Ayurvedic works like 'Susruta' mention it. The leaves have a sweetish taste and their juice is used as a cure for hoarseness; it is applied to painful swellings mixed with bland oils. The root is sometimes used as a substitute for liquorice but it is a poor substitute. Abrine or an infusion of the decorticated seeds of jequirity has been used as an irritant to the eye in cases of granular lids and for corneal opacities. It causes an acute inflammation which improves the condition in some cases, but it must be regarded as an exceedingly dangerous remedy, as the inflammation is entirely beyond control. In animals the eye is often completely destroyed by the application of abrine. In modern medicine, abrine is no longer used.

References:—

(1) Warden, 1882, *Amer. Jour. Pharm.*, 54,251; (2) Martin, 1887, *Proc. Roy. Soc.*, 42, 331; (3) Martin, 1888, *Pharm. Jour.*, 234; (4) Martin, 1889, *Pharm. Journ.* 197; (5) Hooper, 1894, *Pharm. Jour.*, 937; (6) Wienhaus, 1909, *Biochem. Ztschr.*, 18, 228; (7) Ghatak *et al.*, 1932, *Jour. Ind. Chem. Soc.*, 383; (8) Ghatak *et al.*, 1933, *Bull. Acad. Sci.*, Allahabad 69; (9) Simpson, K. S. *et al.*, 1932, *Ind. Jour. Vet. Sci. and Animal Husbandry*, 59; (10) Senov, P. L., 1939, *Chem. Abst.*, 5994; (11) *Wealth of India: Raw Materials*, 1948, I, 494.

ACORUS CALAMUS Linn. (Araceæ)

THE SWEET FLAG

VERN.—Arab.—*Vaj, Vash*; Assam.—*Bach*; Beng.—*Bach*; Dec.—*Gandkilakri, Vach*; Eng.—*Sweet flag*; Guj.—*Gandhilovaj, Godavaj, Vekhand*; Hind.—*Bach, Ghor bach, Gor bach*; Mal.—*Vashampa*; Mar.—*Vekhand*; Pers.—*Agar, Agrec-turki*; Punj.—*Barihoj, Wach*; Sans.—*Bhadra, Bhutanashini, Bodhaniya, Galani, Golomi, Ikshuparni, Jalaja, Jatila, Kanga, Kshudrapatri, Rakshoghni, Shadagrantha, Shataparvika, Schleshmaghni, Ugragandha, Vacha, Vijaya*; Tel.—*Vadaja, Vasa, Wasa*; Urdu.—*Bacha*.

It is a semi-aquatic perennial with indefinitely branched rhizome. It is really a native of Europe and North America but is cultivated in damp marshy places in India and Burma at an altitude of 3,000 to 6,000 ft. It is exceedingly common in Manipur and the Naga Hills, and has established itself on the edges of lakes and streams. The long creeping horizontal rhizomes are collected in the autumn, are cut into pieces and after drying are used medicinally. The plant is also being cultivated in Koratagene taluka in Mysore. An acre of crop yields about a ton and a half of dry marketable rhizomes. Clay soil, loams and light alluvial soils are suitable for its cultivation. The field is irrigated and sown with green manures which are ploughed in before planting. The growing ends or tops of

the previous year's crop are planted one foot apart leaving the leafy portion well above the ground. The crop is ready for harvesting in about a year, the plants are dug out and tops are kept for the next plantation.

CHEMICAL COMPOSITION.—The dried rhizome yields 1.5 per cent. of a neutral, yellow, aromatic, essential oil having an agreeable odour. The fresh aerial parts yield about 0.123 per cent. of the volatile oil; the unpeeled roots, however, give a much better yield from 1.5 to 3.5 per cent. The roots of *A. calamus* yield 0.4 per cent. of oil in the spring and 1.82 per cent. in the autumn. The chief constituent of this valuable oil is asaryl-aldehyde. There is also a bitter glycoside named acorin and certain other substances, such as eugenol, asarone, pinene and camphene are present. Besides these, the drug contains an abundance of starch and a little of tannin. The oil obtained from the Indian *A. calamus* was studied by Rao, Sudborough and Watson (1925). They found that this oil does not contain the lower boiling constituents such as pinene, camphene, etc., in the commercial oil from Europe. Kalkar and Rao (1934) found that the Indian oil contained very high percentage (82 per cent.) of asarone while the commercial oils obtained from other countries contained about 17 per cent. The properties of the Indian oil have been found as follows: Specific gravity, 1.069 at 15°; optical rotation +6.2°; saponification value, 5.1; saponification value after acetylation, 16.6; acid value, 1.4.

THERAPEUTIC USES.—The rhizome is emetic, nauseant, antispasmodic and carminative. In doses of 35 to 40 gr. it produces a violent and persistent emesis. It has an expectorant action due to the presence of the essential oil and is used as a remedy for asthma. The drug is a very old remedy for chronic diarrhoea and forms part of a number of mixtures used in the Hindu medicine. Evers (1875) tried it in chronic dysentery with good results. Henry and Brown (1923) tested it and came to the conclusion that whatever action it had was due to the presence of tannins. Chemically, there is no other constituent which might be held responsible for its astringent action.

References:—

- (1) B. P. C. 1923; (2) Rao, Sudborough and Watson, 1925, *J. Ind. Inst. Sci.*, 8A, 144; (3) Henry and Brown, 1923, *Trans. Roy. Soc. Trop. Med. and Hyg.*, 17, 378; (4) Kalkar and Rao, 1934, *J. Ind. Inst. Sci.*, 25.

ACTINODAPHNE HOOKERI Meissn. (Lauraceæ)

VERN.—Bomb.—*Pisa*; Mal.—*Malavirimji*, *Malavirinni*, *Neyarum*; Mar.—*Pichli*, *Pisha*, *Pissa*; Tam.—*Tali*.

This is a small tree or shrub occurring in Sikkim and on the Eastern and Western Ghats of south India. It is also found in Sattara and particularly at Mahabaleshwar. A cold infusion prepared from the leaves is mucilaginous and is used in the treatment of urinary disorders as well in diabetes. The oil expressed from the seeds is used as an external application in sprains of joints.

CHEMICAL COMPOSITION.—Krishna and Ghosh (1932) isolated from the bark a crystalline alkaloid actinodaphnine which is different from the alkaloids laurotetanine, berberine and luxine found in certain plants of Lauraceæ family. Actinodaphnine, $C_{18}H_{19}O_4$, m.p. 210–11°C. is obtained as stout prisms in 0.7 per cent. yield. From the leaves a dark brown base was obtained in very small quantities which forms an amorphous salt. In all probability the leaves contain alkaloid different from that obtained from the bark of this tree. Puntambekar

and Krishna (1933) obtained from the seeds a small quantity (1.0 per cent.) of an essential oil which from its characteristic appeared to be similar to the oil of *Litsaea zeylanica* which also belongs to the Lauraceæ family. Apart from the essential oil, the seeds contain large quantities of a fat and a fixed oil. The kernels contain a fat which consists mainly of trilaurin (96 per cent.) and endocarp contains an oil which consists mainly of the glycerides of oleic acid. The fat as extracted has never been obtained in pure state and is found to contain small quantities of triolein. The fat and the oil contained glycerides of lauric, oleic, isomeric oleic acids together with sistosterol besides a small quantity of resin acids. The fat appears to be of commercial interest as it could be employed as an indigenous source of lauric acid.

No pharmacological or clinical work has been carried out.

References:—

(1) Krishna, S., and Ghosh, T. P., 1932, *Jour. Ind. Chem. Soc.*, 420; (2) Puntambekar and Krishna, 1933, *Jour. Ind. Chem. Soc.*, 395.

ADHATODA VASICA Nees. (Acanthaceæ)

MALABAR NUT TREE

VERN.—Beng.—*Bakas, Vasaka*; Bomb.—*Adalsa, Adarsa, Adulasa, Adulaso, Adulso, Arusa, Arusha*; Dec.—*Aratora*; Dehra Dun.—*Bansa*; Guj.—*Adsoge, Aduso, Ardusi*; Hind.—*Adalsa, Adarsa, Adulasa, Adulaso, Arusa, Arusha, Bansa, Bashing, Rusa*; Jhelum.—*Bhekkar*; Kumaon.—*Bashangarus, Basinga*; Mar.—*Adulsa, Adulsi, Adusa, Baksa, Vasuka*; Pers.—*Bansa*; Punj.—*Bhekar*; Sans.—*Amalaka, Atarusha, Bashika, Bhishangmata, Kanthiravi, Kasanotpatana, Matrisinhi, Mrigendrani, Nasa, Pancha mukhi, Rakrappittaghi, Ramrupaka, Sinhamukhi, Sinhaparni, Sinhapatri, Sitakarni, Vaidyamata, Vaidyasinh, Vajidantaka, Vajidanti, Vasa, Vasha, Vasika*; Tam.—*Adadoda, Kattumurungai, Vachai*; Tel.—*Addasaramu, Atarushamu*; Urdu.—*Arusa*.

A. vasica is a small evergreen sub-herbaceous bush which grows all over the plains of India and in the lower Himalayan ranges ascending to a height of about 4,000 ft. above the sea level. In Sanskrit it has many names 'arusak' (not angry), 'vansa' (giving perfume), 'vrisha' (chief), 'sinha mukhi' (lion mouthed). The plant has minutely pubescent entire leaves arising from swollen nodes; the flowers are white or purple in colour. It is well-known to the people throughout the country and a yellow dye is commonly obtained from its leaves. The leaves, the roots and the flowers are extensively used in indigenous medicine as a remedy for cold, cough, bronchitis and asthma. It is often given in the form of juice extracted from the leaves, mixed up with ginger or honey, in doses of $\frac{1}{2}$ to 1 oz. A decoction is also made from the leaves and dried leaves are administered in powder form in doses of 30 gr. Both the decoction and powder form constituents of many preparations used in the Ayurvedic medicine for various affections of the respiratory tract. In chronic bronchitis and asthma it is said to be specially efficacious. For the latter disease the dried leaves are made into cigarettes and are smoked. U. C. Dutt says, "the medicine was considered so serviceable in phthisis that it was said, no man suffering from this disease need despair as long

as *Vasaka* plant exists." The juice of the leaves is used in diarrhoea and dysentery in southern India and the powdered leaves are used in malarial fevers. In Burma and in northern India the leaves are applied locally in the form of a poultice on rheumatic joints, inflammatory swellings and in neuralgias. The leaves are said to be toxic to all forms of lower life, prevent the growth of lower aquatics and check the development of parasitic vegetation. According to Watt, the alcoholic extract of the leaves is poisonous to flies, fleas, mosquitoes, centipedes and other insects. From the above remarks it will be seen that the plant is popularly believed to have remarkable medicinal properties.

CHEMICAL COMPOSITION.—As long ago as 1888, Hooper published details of chemical analysis of the drug carried out by himself. He found that an odorous volatile principle probably of the nature of an essential oil and a non-volatile body of the nature of an alkaloid called *vasicine* were present. Hooper's work was confirmed by Boorsma of Java, who further investigated the alkaloid and tested its physiological properties but it has not been possible to find any record of this work. A thorough analysis of the drug was made and sufficient quantities of the alkaloid were obtained to determine its pharmacological action.

The alkaloid is found in the leaves to the extent of 0.25 per cent. The base occurs as needle-shaped crystals and has a melting point of 182°C. It is easily soluble in alcohol, is slightly soluble in cold water but more so in hot water. A 2.0 per cent. solution in chloroform is optically inactive. Vasicine hydrochloride occurs in light, cream-coloured crystals, has a melting point of 180°C and is very soluble in water. Vasicine tartrate was also prepared and is a soluble salt. The molecular weight of vasicine was determined and found to be 188 which agrees with the empirical formula, $C_{11}H_{12}N_2O$, found by analysis.

Gupta *et al.* (1954) obtained an essential oil by steam-distillation of the leaves, flowers and roots with a yield of 0.075 per cent. The oil was golden yellow in colour with a fragrant smell.

PHARMACOLOGY OF VASICINE.—The alkaloid vasicine and its salts are not very toxic to undifferentiated protoplasm. They have little or no effect on the free living protozoa such as *Paramæcium caudatum* nor have they any toxic or inhibitory effect on the cultures and growth of streptococci, staphylococci, *B. coli*, *B. diphtheria* or *B. tuberculosis*. It is possible that the antiseptic properties of the leaves recorded by previous observers may be due to the volatile principle. Solutions of concentrations of 1 to 5 per cent. are not irritant to the mucous membrane. The alkaloid has a bitter taste but has no marked effect on the movements of the alimentary canal. In high concentrations (1 in 20,000) the peristaltic movements of the isolated gut are inhibited, probably owing to depression of the vagal endings. Intravenous injections in animals produce a slight fall of blood pressure due partly to direct depressing effect on the cardiac muscle and partly to depression of the terminations of the vagi in the heart. There is no effect on the blood vessels. In the lungs of experimental animals the alkaloid, when given intravenously, produces a slight but a persistent broncho-dilatation. This action is in all probability due to depression of the vagal terminals in the bronchi as it is absent with small doses of pilocarpine. After administration of atropine, the broncho-dilator effect is more pronounced. The drug has a well-marked expectorant action and it is probable that the essential oil plays an important part in this direction.

ANTI-BACTERIAL ACTIVITY OF THE OIL.—Gupta and Chopra studied the anti-bacterial properties of the essential oil and made the interesting observation that whereas the oil did not inhibit the growth of non-acid-fast pathogenic bacteria in concentrations as high as 500 microgram/c.c., the growth of all the strains of *Myc. tuberculosis* was inhibited in concentrations ranging from 2 to 20 micrograms per c.c. in Youman's modified medium. It would thus appear that essential oil of *A. vasica* has a marked selective anti-bacterial activity

against *Myc. tuberculosis*, producing inhibition of growth in culture medium in concentrations of 1 in 500,000. Under the electron microscope the bacilli appear to be swelled up under the influence of the drug incorporated in the culture medium. The oil was also shown to possess a very low toxicity in studies on albino mice and guinea-pigs.

THERAPEUTIC USES.—Clinically, an alcoholic extract made from fresh and dry *Adhatoda* leaves was given an extensive trial in the Carmichael Hospital for Tropical Diseases. Previously a tincture made from the leaves was tried in various civil hospitals and dispensaries in different parts of India at the instance of the Indigenous Drugs Committee. Most of the evidence produced showed that the drug has a definite expectorant action. In acute bronchitis it was found always to afford relief, especially where the sputum was thick and tenacious, acting in very much the same way as *ipecacuanha*. In chronic bronchitis the cough is relieved and the sputum is liquefied so that it is brought up more easily. The depression of the vagal terminations further relieves irritation and spasm of the bronchioles. The extract was also tried in a number of cases of bronchial asthma but relief afforded by it was not marked. As the animal experiments pointed to synergistic action of atropine and vasicine a combination of the extract with belladonna preparations was tried in cases of asthma of vagotonic origin but the results were not very satisfactory. As regards the effect of the drug in tuberculosis of the lungs the author's conclusions are also in accord with those of the Indigenous Drugs Committee. The drug is absolutely useless in curing or preventing the progress of this disease in experimental animals or human beings. There is no doubt, however, that it relieves the irritable cough by its soothing action on the nerves and by liquefying the sputum which makes expectoration easier. A syrup prepared from the leaves is commonly used by practitioners in India in the treatment of lung troubles as a sedative expectorant.

SUMMARY.—Chemical analysis of *A. vasica* shows the presence of two active principles: (a) an alkaloid *vasicine* whose empirical formula we have found to be, $C_{11}M_{12}N_2O$, of molecular weight 188, (b) traces of a volatile principle of the nature of an essential oil. Vasicine has no marked action on the alimentary canal or on the circulation. It produces slight but persistent broncho-dilatation in experimental animals and this effect is considerably increased after administration of atropine. The essential oil present in the leaves appears to be chiefly responsible for the expectorant action of the drug. Clinically, the fluid extract prepared from the leaves has wellmarked expectorant properties, it relieves cough, liquefies sputum which is then coughed up more readily. It is not effective in relieving attack of bronchial asthma. In pulmonary tuberculosis it has no action whatever.

References:—

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ÆGLE MARMELOS Correa (Rutaceæ)

BAEL FRUIT

VERN.—Arab.—*Safarjalehindi, Shul*; Assam.—*Bel*; Beng.—*Bel, Bela, Vilva*; Bomb.—*Bela, Bila*; Eng.—*Bael fruit, Bengal quince, Golden apple, Holy fruit, Indian quince, Stone apple*; Guj.—*Bil, Billy*; Hind.—*Bel, Bili, Sirphal, Siriphal*; Kumaon.—*Bel*; Mal.—*Kuvalam, Mavilavu, Vilvam*; Mar.—*Bel*; Pers.—*Safarjalehindi, Shul*; Sans.—*Adhararuha, Asholam, Atimangaliya, Bilva, Duraruha, Gandhapatra, Goharitaki, Karkatavha, Pitaphala, Satyadharma, Sâtyaphala, Shailapatra, Shandilya, Shivadruma, Shiveshtha, Tripatra*; Tam.—*Aluvigam, Iyalbudi, Kuvilam, Mavilangai, Vilvam, Villuvam*; Tel.—*Bilvamu, Maluramu, Maredu, Sripthalamu*; Urdu.—*Bel*.

The tree is indigenous to India and is found wild all over the sub-Himalayan forests, in Bengal, in central and south India and in Burma. It is also cultivated to a great extent. It is held sacred by the Hindus and its leaves, which are ternate, are presented to God Shiva as offerings by the devotees. It is often planted near the temples. The Hindus consider it an emblem of fertility and a very auspicious plant. In the Hindu medicine different parts of the bael tree are used. The root bark is used in the form of a decoction as a remedy in hypochondriasis, melancholia, intermittent fever and palpitation of the heart. It constitutes an ingredient in the 'Dasamul' or ten roots used by the Hindu physicians. The leaves are made into a poultice and applied to inflamed parts. The fresh juice is bitter and pungent, and when diluted with water is praised as a remedy in catarrh and feverishness. The fruit, both green and ripe is used against diarrhoea and intestinal conditions. For diarrhoea and dysentery the roasted or sundried unripe fruit cut in slices is generally used. The astringent rind of the ripe fruit is employed in dyeing and tanning and it is also used medicinally. No drug has been longer and better known nor more appreciated by the inhabitants of India than the bael fruit. Two kinds of fruit are available in the market—a small and wild variety and a large cultivated variety. The full-grown fruit of either variety, when it just begins to ripen, is best for medicinal purposes:

(1) The unripe or half-ripe fruit is regarded as an astringent, digestive, stomachic and is said to be an excellent remedy for diarrhoea owing to the presence of tannins or mucilaginous substances. It is said to be particularly useful in chronic diarrhoeas. It is sometimes used in combination with opium by the Ayurvedic practitioners. The fruit is also sliced and a confiture made from it is largely used by the Hindu physicians in the treatment of diarrhoeas and dysenteries.

(2) The ripe fruit is sweet, aromatic and cooling. When taken fresh it possesses laxative properties. The dried pulp is pale orange or flesh-coloured and when mixed with water yields a pleasant orange-coloured 'sherbet' which has mild astringent properties.

CHEMICAL COMPOSITION.—According to some authorities, bael contains tannic acid, a

volatile oil, a bitter principle and a balsamic principle resembling balsam of Peru. These findings have, however, been criticised by Flückiger and Hanbury who are of opinion that the dry pulp of the fruit contains chiefly mucilage and probably pectin. They could not find any appreciable quantity of tannin to account for the astringent properties so often ascribed to the drug. Henry and Brown (1924) examined the fruit along with a number of reputed antidyenteric remedies. The dried pulp was exhausted with boiling alcohol, the extract concentrated *in vacuo* and the thick syrup diluted with water to precipitate fatty and resinous matters. The liquor from this precipitate, after concentration *in vacuo* to remove all alcohol, was tested by them on a free living ciliate protozoon, *Glaucoma*. The solution was found to be markedly toxic to *Glaucoma* but owing to the large amount of gum present it proved difficult to get a satisfactory preparation of the tannins of the plant but even in the impure form these appeared to be fairly active. They came to the conclusion that the drug may owe its activity to the tannins that are present since these are toxic to *Glaucoma*. Dutt and Dikshit (1930) exhausted the roots, seeds, bark, leaves and fruits with various solvents and the composition determined in each case. The roots, leaves and bark were found to contain reducing sugars and tannin mainly. The fruit pulp yielded, in addition to the usual substances, a body which has been named *marmelosin*. This is considered to be one of the most important active principles of the fruit. The seeds, when crushed and extracted with petroleum ether, gave a light yellow oil which has been found to possess very good purgative properties when taken internally in doses of 1.5 gm.

Marmelosin is present in the fruit and in no other part of the plant, the percentage varying from 0.03 to 0.37 according to locality and cultivation. The small wild varieties of the fruit contain proportionately much less than the large cultivated variety. The drier the climate the smaller also is the yield of marmelosin. Fruits obtained from Bengal and Assam contain more than five times as much marmelosin as those obtained from Uttar Pradesh and the Punjab. The greatest concentration of marmelosin is in the inner layer of the pulp, which is also incidentally the sweetest and most edible and which is administered for therapeutic purposes. Physiologically, marmelosin is an exceedingly potent drug. Taken in doses of 0.05 gm. it acts as laxative and diuretic. It decreases slightly the frequency of respiration and has a tendency to produce sleepiness. In larger doses it acts as strong depressant to the heart. The bark (from old trees in Bihar) contains 0.33 per cent. of an alkaloid, $C_{13}H_{11}O_3N$, m.p. $142^{\circ}C$., which was shown by Chakravarty to be identical with fragarine from the leaves of cocoa. From the bark Dixit and Dutt (1932) isolated umbelliferone and other coumarines different from marmelosin obtained from fruits. Their proportion, however, varies with the age of the bark and also the locality from which it has been obtained.

Asima Chatterjee (1949) extracted the matured bark and obtained number of crystalline products. These are: (1) a new coumarin which has been named marmesin, $C_{14}H_{14}O_4$, m.p. $189.5^{\circ}C$. It is furo-coumarin and an optical isomer of nodakenetin; (2) an alkaloid fragarine, $C_{13}H_{11}O_3N$, m.p. $143^{\circ}C$. and umbelliferone, $C_9H_6O_3$, a hydroxy coumarin. It has been observed that the crystalline constituents of the immature bark of *A. marmelos* are different from those of the mature bark. The coumarin isolated from the immature bark is a new substance not hitherto obtained from natural sources. It has been named marmin, $C_{19}H_{24}O_8$, m.p. $123-24^{\circ}C$., yield 0.03 per cent., and is an ester of umbelliferone. The second crystalline substance is an alkaloid, $C_{14}H_{18}O_4N$ (yield 0.003 per cent.), m.p. $176-77^{\circ}C$., which has been shown to be identical with skimmianine. The third active principle is the same as present in the matured bark, i.e., umbelliferone. From the leaves an alkaloid nutacine identical with skimmianine, a sterol and aegelin ($C_{18}H_{18}O_4$) m.p. $175^{\circ}C$. have been isolated. The seeds of the fruit contain 34.4 per cent. of a fixed oil; the kernels contain 8.35 per cent. moisture and 49.1 per cent. of oil (dry basis). The composition of the oil is approximately: palmitic acid 15.6, stearic acid 8.3, oleic acid 28.7, linoleic acid 33.8, and linolenic acid 7.6 per cent. The extracted kernels contain over 70 per cent. protein probably a globulin. Basila and Deshpande (1949) reported the presence of an essential oil in the leaves of the

plant which contained a-d-phellandrene (56 per cent.), cineol citronellal, citral, p-cymene (17 per cent.), cuminaldehyde (5 per cent.). The essential oil from the twigs contained cineol (40-45 per cent.) and a-d-phellandrene (34.5 per cent.). The essential oil from fruit contained a-d phellandrene only.

THERAPEUTIC USES.—Bael is believed to be an invaluable remedy in obstinate cases of chronic diarrhoea and dysentery, where there is no fever, and is given either in the form of a powder or in the form of a confection. It was so commonly used by the Western practitioners in India in old days that it found its way into the British Pharmacopoeia. The three preparations commonly used were: (1) Extract of bael made from fresh unripe fruit given in half to one dr. doses several times a day, (2) liquid extract of bael prepared from dried slices of unripe fruit prescribed in doses of one to two dr., (3) powdered dried pulp kept in air-tight bottles given in doses of half to one dr.

There is hardly any literature of recent date on the use of the bael fruit in amoebic dysentery. It appears to have little or no effect in acute dysentery when there is definite tenesmus and discharge of blood and mucus though the powdered drug is especially recommended for this condition. The beneficial effects of the bael fruit is, however, most evident when the condition has become subacute or chronic. After its administration in these conditions, the blood gradually disappears and the stools assume a more foeculent and solid form. If bael is continued for sometime, the mucus is also decreased and may disappear. It is very useful in patients suffering from chronic dysenteric condition characterised by alternate diarrhoea and constipation. Claims have also been made that it relieves flatulent colic in patients suffering from a condition of chronic gastro-intestinal catarrh. In the after treatment of bacillary dysentery, bael is a useful adjuvant. According to Acton and Knowles (1927) the chief trouble with such patients, as a rule, is constipation which if not relieved does not allow the ulcerated surfaces to heal firmly. Bael 'sherbet' is a useful addition to the dietary at this stage and acts chiefly as a demulcent. The pulp of the fresh fruit may be mixed with sugar and cream or with curds or made into a 'sherbet' by straining it through a piece of muslin to remove seeds and mucilage. In cases of sprue also, the bael fruit has been spoken of highly by Manson-Bahr. In many patients, especially those in the pre-sprue or early stages of the disease, it is undoubtedly helpful. The fresh fruit is best taken raw mixed with sugar though dried fruit has also been recommended.

SUMMARY.—Bael fruit has been used in the indigenous medicine for a very long time and it had such a great reputation in the treatment of diarrhoeas and dysenteries that it was made official in the British Pharmacopoeia. Besides tannins, no other active principle of any importance have so far been discovered. It has very little beneficial action in acute dysenteries but in chronic cases it relieves symptoms on account of the presence of large quantities of mucilage which acts as a demulcent. It does not appear to have any specific effect in either amoebic or bacillary dysentery.

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ALANGIUM LAMARCKII Thwaites (Cornaceæ)

VERN.—Beng.—*Akarkanta, Angkula, Angkura, Ankoda, Baghankura, Dhalakura*; Bom.—*Ankola, Kalaakola*; Guj.—*Ankola, Ankoli, Ankolya, Onkla*; Hind.—*Akhaul, Akol, Akola, Anedhera, Ankora, Dhera, Kweli, Thaila ankul*; Mal.—*Alinnil, Ankolam, Chem, Karankolam, Kimri, Valittonti*; Mar.—*Ankol, Ankoli, Ankul*; Saharanpur.—*Bismar*; Sans.—*Ankola, Ankolaka, Ankota, Ankotaka, Ankotha, Bodha, Bhushita, Dirghakila, Dirghakilaka, Dridhakantaka, Gandhapyshpa, Ghalanta, Gudhapatra, Gudhavallika, Gunadhyaka, Guptasncha, Kankarola, Kolaka, Lambakarna, Pitasara, Tamraphala, Vishaghna, Vishalatailagarbha*; Tam.—*Adigolam, Alangi, Alinjil, An, Angolavayiravan, Attigolam, Karikkolam, Karuppuvalinjil, Oru, Sem*; Tel.—*Ankolamu, Nallankolamu, Nalluduga, Uduga, Uru*; Urdu.—*Ankola*.

It is a deciduous shrub or a small tree met with in forests throughout India and Burma. The root bark is used in indigenous medicine as an anthelmintic and purgative. It has also a reputation in leprosy and skin diseases. Mohideen Sheriff found it to be an efficient emetic in 45 to 50 gr. doses and a good febrifuge in 2 to 5 gr. doses.

CHEMICAL COMPOSITION.—A preliminary assay of the bark showed the presence of about 0.82 per cent. of an alkaloid on the air-dried material. Systematic chemical examination gave the following results: (a) Petroleum ether extract (35° to 70°), 0.40 per cent.; (b) Absolute ether, 0.66 per cent.; (c) Absolute alcohol, 4.01 per cent.; (d) Alcohol (70 per cent.), 3.5 per cent. Detailed chemical study revealed the presence of an alkaloid and a fair amount of potassium chloride but no tannins or glycosides. The base was purified to a great extent but all attempts to prepare a crystalline salt have thus far been frustrated. The sulphate of the base was obtained as a white powder which was found to be hygroscopic and had a tendency to turn yellow on keeping. The base was obtained in an amorphous form m.p. 80-82°C., yield (0.8 per cent.) and was named provisionally alangine. Dutta and Parihar (1942) working with the bark obtained an alkaloid to which the name alangine was given; it melted at 205-8°C. with decomposition and had the composition, $C_{19}H_{25}NO_2$. By extraction with benzene he also obtained from the seeds a sterol, $C_{47}H_{84}O_7$, m.p. 296°C. to which the name alangol has been given. Basu (1950) reinvestigated the plant and obtained from the alcoholic extract of the bark three new bases not reported before: (1) Akhar kantine, a yellowish-brown crystalline base m.p. 146-8°C. (2) Ankoline, $C_{17}H_{36}N_2O_4$, brownish yellow crystals m.p. 110°C. (3) Lamarkine, $C_{13}H_{12}N_2O_8$, yellow crystals m.p. 60-2°C. Singh and Tewari (1948) isolated from the bark two isomeric alkaloids alangium A and alangium B. Alangium A, (yield 0.15 per cent.) is a light brown crystalline solid, formula, $C_{21}H_{28}O_8N$, m.p. 219-20°C. with decomposition. Alangium B (yield 0.01 per cent.) is a cream coloured

amorphous solid m.p. 105-7°C. The third a distinct alkaloid alanginine (yield 0.001 per cent.) was obtained as a cream-coloured solid m.p. 245-7°C.

PHARMACOLOGICAL ACTION.—The pharmacological action of the sulphate of the active principle of *A. lamarckii* has been studied in the department of Pharmacology, Calcutta School of Tropical Medicine. In doses of 4 to 5 mg. per kilo body weight, administered intravenously in cats, alangine sulphate produces a sharp fall of blood pressure of about 30 to 40 mm. This fall is only temporary and within 1 to 2 minutes the blood pressure returns to the normal level. The auricles and the ventricles are dilated and the strength of the heart beats is reduced. Depression of the heart is also noticed in isolated perfused mammalian hearts. Respiration becomes irregular. The tone and the peristaltic movements of the intestines are increased and there is an increase in the volume of the intestines, the spleen and the kidney. Later work showed that the bark contains a lemon yellow amorphous alkaloid, alangine (m.p. 81-82°C.), which has a selective action on the parasympathetic mechanism. The action is most marked on the gastrointestinal tract. On the circulatory and respiratory systems, the action of the alkaloid is much less in evidence. The medullary centres are probably stimulated, especially the vomiting centre. Sweat secretion is increased due to the stimulation of the parasympathetic nerve endings. Whether the drug has any action on the sweat glands themselves cannot be definitely stated.

THERAPEUTIC USES.—The claims made regarding the therapeutic efficacy of the drug have not been investigated.

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ALLIUM SATIVUM Linn. (Liliaceæ)

GARLIC

VERN.—Arab.—*Saum, Taum*; Assam.—*Naharu*; Beng.—*Lashan, Lasun, Rasun*; Bomb.—*Lusoon*; Dec.—*Shunam*; Eng.—*Churls' Treacle, Garlic, Poor man's treacle*; Guj.—*Lasan*; Hind.—*Lahsan, Lasan*; Mar.—*Lasun, Lasunas*; Pers.—*Sir*; Sans.—*Arishtha, Bhutabhna, Dirghapatraka, Katukanda, Lashuna, Mahakanda, Mahaushana, Rahuchhishta, Rasona, Rasonaka, Shuklakanda, Ugragandha, Vatari, Yavaneshta*; Tam.—*Vellaippundu*; Tel.—*Vellullitellagadda*; Urdu.—*Lehsun*.

Garlic is very commonly found all over India. Not only does it grow wild, but is also extensively cultivated on account of its use as a spice. As a medicine, garlic was held in great repute by the ancient physicians of India. It is considered to be hot and stimulant, and is administered in fevers, coughs and other debilitating conditions. It has also a reputation as a febrifuge in intermittent fevers. Externally, the juice is used as a rubefacient in skin diseases and as ear drops in ear-ache and deafness. It has also been used to a fairly large extent in Western medicine.

CHEMICAL COMPOSITION.—The active principle of garlic is a volatile oil which may be readily obtained by distilling the bruised bulbs. The oil is a clear limpid liquid of a dark brown or yellow colour; it has an intense garlic odour and the yield is from 0.06 to 0.1 per cent. Its specific gravity at 14.5° is 1.0525 and it is optically inactive. When purified it is colourless and can be distilled without decomposition. With some samples, even at winter temperature, the oil becomes semi-solid through the deposition of fine crystals. Semmler found that the oil decomposes when heated to 150°C. Fractionated under 16 mm. pressure, four different fractions were obtained:

Fraction I (6 per cent.) consists of allyl propyl disulphide. It has the odour of onions and gives a voluminous precipitate with mercuric chloride. *Fraction II* (60 per cent.) consists of diallyl disulphide which has the odour of garlic. It is rendered colourless by distilling with a little potassium. *Fraction III* (20 per cent.) boils between 112° to 122°C. at 16 mm. pressure. *Fraction IV* (10.5 per cent.) boils above 122° at 16 mm. pressure and decomposes on further distillation. It consists mainly of polysulphides. It will thus be seen that garlic does not contain any allyl sulphide in any of the different fractions obtained by distillation. Allyl sulphide was previously thought to be the chief constituent.

Cavallito and co-workers (1944) isolated allacin the antibacterial principle from ground garlic cloves. It has probably the formula, $C_6H_{10}OS_2$ (mol. wt. 162), it is irritating to the skin and the odour is more characteristically that of garlic than is that of various allyl sulfides. It is relatively stable in 0.2 per cent. aqueous solution and is very unstable in pure state. Nevertheless, it is present in whole garlic to the extent of 0.3-0.4 per cent. and appears to be stable therein over long period of time. Later on, the name allacin was discarded in view of possible confusion with established medicinal products.

Siddiqui and co-workers (1947) while investigating sulphur containing antibiotic principles of plant origin, re-investigated garlic and observed that by dialysing the whole clove with ether for a period of six hours, highly active concentrate was obtained in a yield of 0.4 per cent. Fractionation of the active principle by a process of partitioning between non-miscible solvents showed that there are two active substances present in garlic, one of which is active against staphylococcus and *B. coli* whereas the second shows activity towards staphylococcus only. The substances were provisionally named allisatin I and allisatin II. Apart from the above active constituents, a crystalline substance, m.p. 79-80°C. has also been isolated from the alcohol insoluble fraction of the residue.

PHARMACOLOGICAL ACTION.—Cavallito tested allacin against various organisms. It is about equally effective against gram-positive and gram-negative organisms, the activity is equivalent to about 1 per cent. of penicillin. LD₅₀ in aqueous solution is of the order of 60 mg. per kg. given intravenously and 120 mg./kg. by subcutaneous administration. Venkatraman and others (1946) tested the oil obtained from garlic. They observed it to be anti-bacterial against typical gram-positive, gram-negative and acid fast bacilli and to possess antifungal properties. It is comparatively stable in the presence of blood and artificial gastric juice but is inactivated by artificial pancreatic juice. It inhibits the milk clotting activity of papain and the amylolytic activity of β -amylase, probably by reacting with -SH enzymes. Torrescasana (1946) showed that garlic contained at least two pharmacologically active substances. The first chloroform-soluble substance had an antiseptic action, a slightly tonic effect on isolated frog heart, a slightly hypertensive effect on etherized cats and a paralyzing effect on isolated rabbit intestine. The other chloroform insoluble, has no antiseptic effect, no action on isolated frog heart, a strong hypotensive effect on etherized cats and a tonic effect on isolated rabbit

intestine. The alcoholic extract given by stomach tube to rats produced no consistent visceral damage.

THERAPEUTIC USES: *External Application.*—Garlic juice has been employed as an antiseptic in ulcerated surfaces and wounds with satisfactory results. Garlic juice mixed with 3 or 4 parts of ordinary or distilled water (*succus allii*) has been used as a lotion for washing wounds and foul ulcers. Definite improvement in the condition of infected wounds was noticed within 24 hours after washing with this lotion and a very marked and decided improvement within 48 hours. Not only was the purulent discharge markedly decreased but the pain was also considerably relieved and in some cases it entirely disappeared. No injury to the tissues could be noticed as a result of application of this solution. Though the carbolic acid co-efficient of this solution was found to be rather lower than other antiseptics (Rideal-Walker co-efficient=2), it possesses the distinct advantage of being much less irritant to the tissues than carbolic acid. Whereas it is seldom possible to use carbolic acid lotion in a great strength than 1 in 40 ($2\frac{1}{2}$ per cent.) the *succus allii* can be employed in a strength of 20 to 25 per cent. without apparent injury to the tissues. Minchin (1916) states that he has used allium preparations in the treatment of suppurating wounds and foul ulcers for 15 years and obtained very satisfactory results.

INTERNAL ADMINISTRATION.—Garlic is an excellent medicine in several forms of atonic dyspepsia. *Succus allii* has been administered in 10 to 30 minim doses in several cases of flatulence and colic and good results have been reported. The essential oil of garlic is absorbed into the circulation and is excreted through the lungs and bronchial mucosa acting as a good antiseptic and antispasmodic. Lamb (1925) recommends garlic in the form of tinct. *allii*, either alone or in combination with the usual expectorant mixtures. When there is much gastro-intestinal catarrh, garlic in the form of an ointment is rubbed on the abdomen, a binder being applied afterwards. It is said to be very effective in bronchial and asthmatic complaints. According to Minchin (1916) garlic is a remedy for many disease conditions. He considers it as a prophylactic in typhus, typhoid and diphtheria. He advises in the first two diseases the trial of 1 drachm of *succus allii sativi* every four to six hours, given in beef tea or with syrup. For a child under twelve, $\frac{1}{2}$ dr. in syrup is sufficient. Given early in typhoid fever it will almost abort the disease, and its action as an intestinal antiseptic makes it valuable at any stage of the disease. In diphtheria the constant application obtained by chewing a 'clove' of garlic removes the membranes, reduces temperature and relieves the patient. About 1 or 2 oz. of garlic can be used in this way in three or four hours. For a week after the membrane disappears, 1 or 2 oz. of the bulb should be chewed daily. The diphtheritic patient has no taste or smell, and merely finds the garlic hot. Used in an inhaler three to four hours daily the *succus* rapidly relieves the distressing features of whooping cough. For young infants and children 20 to 30 minims of the *succus* in syrup every four hours gives rapid relief in early cases.

Crossman (1918) thinks that garlic, if given in sufficient doses, is an invaluable remedy in the treatment of pneumonia. He used it for 2 years in the treatment

of lobar pneumonia and, according to his published report, in no instance has it failed to bring the temperature, pulse and respiration down to normal in about 48 hours. In no case was the crisis deferred beyond the 5th day of the disease. He chiefly used tinct. allii made from garlic bulbs (strength 1 in 5) and gave it in doses of half a drachm of the drug in water every 4 hours. The results in other bronchial infections, e.g. bronchitis, bronchiectasis, foetid bronchitis and influenza, were no less promising.

In pulmonary phthisis, garlic and its preparations have been used very extensively. There are several proprietary preparations on the market at the present time which contain either the juice of garlic or its constituents. In tubercular affections of the lungs, garlic juice often diminishes the obstinate cough and expectoration. The appetite is improved and in some cases night sweats are also known to subside completely. As a result of the sensation of well-being and comfort produced, sleep is induced and digestion improves resulting in gain in weight. Minchin (1916) warmly advocates the use of garlic preparations in tuberculous affections. According to him, allyl sulphide can be used in all tuberculous lesions in accessible situations or in those which can be rendered accessible. He has treated a number of cases of tuberculosis of the larynx in man by $\frac{1}{2}$ to 1 dr. doses of the juice 2 to 3 times a day and has always obtained very good results.

From the satisfactory clinical results, further studies are called for.

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ALPINIA GALANGA Willd. (Zingiberaceæ)

THE GREATER GALANGAL

VERN.—Arab.—*Khowlanjan*, *Khulanjan*, *Khulanjanekabir*, *Khulanjanegasbi*; Beng.—*Barakalijan*, *Barakulanjan*, *Kulanjan*, *Kulinjan*; Bomb.—*Baripankijar*, *Malabaripankijar*; Dec.—*Barakhulanjan*, *Baripankijar*, *Sufedpankijor*; Eng.—*Greater galangal*, *Java galangal*; Guj.—*Kolinjan*; Hind.—*Barakalijan*, *Barakulanjan*, *Kulanjan*, *Kulinjan*; Mal.—*Aratta*, *Perasatta*; Mar.—*Koshtkulinjan*; Pers.—*Khurdwara*, *Khusraveduruekalan*; Sans.—*Aruna*, *Dhumala*, *Elaparni*, *Gandhamula*, *Gandhavaruni*, *Kapidruma*, *Koraja*, *Kulanja*, *Kulanjana*, *Mahabharavacha*, *Nakuli*, *Patala*, *Purusha*, *Raktarenu*, *Raktapushpa*, *Rasna*, *Sugandha*, *Sugandhavacha*, *Sugandhayoga*, *Tikshnamula*; Sind.—*Kathi*, *Kunjar*; Tam.—*Anandam*, *Arattai*, *Ardubam*, *Kandanaguliyam*, *Perarattai*; Tel.—*Dumparashtrakamu*, *Kachoramu*, *Peddadumparashtrakamu*; Urdu.—*Kulanjan*.

It is a perennial plant found in East Bengal and south India. It is a native of Sumatra and Java but is now completely naturalised in many parts of India. The plant has a reputation in the indigenous system of medicine and is fairly largely used in southern India. In Mysore, it is a domestic medicine and is much used by old people with bronchial catarrh. The rhizomes are useful in rheumatism and catarrhal affections. The tubers and seeds are said to possess carminative properties and are used as a fragrant adjunct to complex prescriptions. In the Mohammedan medicine, it is considered to be a good remedy for impotence and nervous debility.

CHEMICAL COMPOSITION.—The constituents of Galangal root have been isolated by Jalius (Kirtikar and Basu). He found three different compounds, campheride, galangin, and alpinin. No detailed chemical work has recently been done to confirm these findings. From the green rhizomes, a pale yellow oil with a pleasant odour can be obtained on distillation. This oil contains 48 per cent. of methyl cinnamate, 20 to 30 per cent. of cineole, camphor and probably d-pinene.

PHARMACOLOGICAL ACTION.—Intravenous injections of small doses of a tincture or an infusion of *A. galanga*, produce a sharp fall in blood pressure in experimental animals. The blood pressure, however, comes to normal in a short time. The fall in blood pressure is accompanied by a rise in the volume of the intra-abdominal organs like the spleen and the intestines showing that dilatation of the splanchnic blood vessels is one of the causes of the fall of blood pressure. The contractions of both the auricle and the ventricle are lessened showing that the drug has a depressant action on the heart. Dilatation of the peripheral blood vessels is observed when they are perfused with physiological saline solutions containing various concentrations of the drug. The drug is a depressant to the cardio-vascular system.

Respirations in experimental animals are stimulated in small doses but depressed with larger ones, the respiratory centre being paralysed. The important action of the drug is, however, on the bronchioles. Even small doses produce a dilatation of the bronchioles and this effect is much more pronounced when the dose is increased. Asthma-like conditions produced artificially in animals by administering pilocarpine are immediately relieved by small doses of the tincture of *A. galanga*.

The drug has no marked action on other systems of the body. The secretion of urine is slightly diminished, but this effect appears to be vascular, for the rate of secretion comes to normal as soon as the blood pressure comes to normal. The isolated uterus is relaxed and its contractions become regular. The action on the gastro-intestinal tract is similar to that produced by other essential oils.

THERAPEUTIC USES.—As a volatile oil is one of the important constituents of the drug, suggestions have been made to try it for the same purposes as the other volatile oils, e.g. as a carminative. The drug has a slight irritant action on the mucous membrane of the stomach and this may be used in producing a reflex increase in the bronchial secretion. As the oil is excreted through the lungs it acts as an expectorant. It appears, therefore, that the popular use of the drug as a remedy for many respiratory ailments is justified. Yajolu found that administration of a paste of *A. galanga* in honey lessened the paroxysms of cough in children suffering from whooping cough. He also found that in young children suffering from bronchitis administration of this drug relieved the distressing symptoms and also had a favourable action on the temperature of the patients. The drug, therefore, promises to be of use in respiratory troubles especially those of

children. The antispasmodic action of the drug may also prove useful in conditions like asthma. In affections of the gastro-intestinal tract the drug can be used like other volatile oils. It has got the advantage of having a very pleasant odour and thus may be used in cough and digestive mixtures. It has been suggested that it may be useful in intestinal and biliary colic.

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ALSTONIA SCHOLARIS R. Br. (Apocynaceæ)

DITA BARK

VERN.—Assam.—*Chatian*, *Satiana*; Beng.—*Chatium*, *Chatwan*, *Chhatim*; Bomb.—*Satvin*; Hind.—*Chatium*, *Saitankajhad*, *Satium*, *Satni*, *Satwin*; Kumaon.—*Chatium*; Mal.—*Daivapala*, *Elilampala*, *Kotapala*, *Mangalappala*, *Mukkampala*, *Pala*; Mar.—*Saptaparni*, *Satuin*, *Satvin*, *Satwin*; Nepal.—*Chatiwan*; Sans.—*Ayugmachchhada*, *Ayugmaparna*, *Ayukachhada*, *Bahuparna*, *Brihattvaka*, *Chatraparna*, *Dalegandhi*, *Devavriksha*, *Gandhiparna*, *Grahanasha*, *Grahanashana*, *Grahashi*, *Guchhapushpa*, *Jivani*, *Munichhada*, *Palagaruda*, *Saptachhada*, *Saptaparna*, *Sarada*, *Shalmalipatraka*, *Sharadipushpa*, *Shirarujam*, *Shuktiparna*, *Sringiritika*, *Suparnaka*, *Sutipatra*, *Vinyaka*, *Vishalatvaka*, *Vishamachhada*, *Yugmaparna*; Tam.—*Elilaippalai*, *Maranallari*, *Mukkanbalai*, *Palai*, *Vadirasi*; Tel.—*Edakulapala*, *Edakulaponna*, *Edakularati*, *Palagaruda*.

A. scholaris is a tall evergreen tree widely cultivated throughout India and found in the sub-Himalayan tract from the Jumna eastward ascending to 3,000 ft. The tree is also found in abundance in Bengal and southern India. The bark of the tree has been reputed in the Hindu medicine for ages as a tonic, alterative, useful in fever and skin diseases. Another allied species, *A. constricta*, does not appear to grow in India.

CHEMICAL COMPOSITION.—An uncrystallisable bitter principle called 'ditain' was isolated long ago. To this was ascribed the febrifuge properties of the drug. Later investigations showed that the constituents of the bark were: (1) An alkaloid *ditamine*, (2) a substance resembling an alkaloid, (3) a crystallisable acid and (4) a fatty acid and fatty resinous substances. Bacon (1906) found that the bark contains two alkaloids—*ditamine* and *echitamine*. *Ditamine* can be separated from its solutions by making them alkaline with sodium bicarbonate and extracting with ether; *echitamine* is obtained by making the solution strongly alkaline with NaOH and extracting with chloroform. The total alkaloidal content of Indian bark is 0.16-0.27 per cent. and 0.08-0.10 per cent. of the hydrochloride of the chief alkaloid *echitamine*, $C_{22}H_{28}O_4N_2$, m.p. 206°C .; higher values have been reported (0.5 per cent. of *echitamine*) in bark from Shimoga area in Mysore. From the mother liquor of *echitamine*, Goodson isolated small quantities of another crystalline alkaloid, *echitamidine*, $C_{29}H_{38}O_5N_2$, m.p. $135-6^{\circ}\text{C}$. Among the non-alkaloidal constituents, Goodson has isolated two isomeric lactones, $C_8H_{14}O_3$, m.p. 103°C . and 107°C . The latex is found to contain 2.8 to 7.9 per cent. caoutchouc. The coagulum contains caoutchouc 12.9-26.5 and resins 69.0-78.7 per cent. It tastes bitter and is said to be applied to sores and ulcers.

PHARMACOLOGICAL ACTION.—Bacon studied the action of the alkaloid echitamine in the Philippines. He found that it is not a protoplasmic poison. Amoebae suspended in a 1 per cent. solution of echitamine hydrochloride seem to thrive; there is no decrease in their motility even after exposure for 2 hrs. Patricia and Shaw (1943) found that addition of 200 mg. of the mixed sulphates of alstonia alkaloids to the bath containing a strip of rat intestine caused a decrease in tonus, a cessation of movement for a time and then a rythmical movement with increasing amplitude. Both quinine and alstonia alkaloids abolished the effect of acetylcholine and barium and lessened those of adrenaline and potassium. On the rat or guinea-pig isolated uterus alstonia alkaloids sometimes caused a contraction and sometimes a relaxation. When 20 mg. was injected intravenously into a cat, there was marked contraction of the nonpregnant uterus. A concentration of 1 in 5,000 to 10,000 effected a decrease in amplitude without alteration of the frequency of beats of the frog's heart (Straub prepn.). In the intact cat alstonia alkaloids in doses of 3-5 mg./kg. given intravenously caused a sharp fall in blood pressure but very little alteration in heart rate. Larger doses caused irregularities in rhythm, heart block and sometimes ventricular fibrillation. About 5-10 min. after the administration of alstonia alkaloids the injection of adrenaline brought about a fall in blood pressure. Alstonia alkaloids in amount of 0.8 mg./kg., produced initially a fall in tension in striated muscle in the intact dog (technique similar to that described by Brown, 1938) followed by a very slight increase. After eserization of the muscle the large increase in tension developed was reduced to about 20 per cent. of its original value.

THERAPEUTIC USES.—The fame of 'dita' as a healing agent dates from great antiquity. It was at one time thought to be very useful in malaria and other fevers, so much so that it was stated that equal doses of ditamine and sulphate of quinine would have the same medicinal effects. In the Manilla Hospital, the results of trials obtained in malaria were very satisfactory and it was reported that it would completely replace quinine in malignant tertian fevers. The drug was tried in India at the instance of the Indigenous Drugs Committee. It was administered to 14 cases of malaria, in all of which it caused the temperature to fall steadily to normal in a short time. No perspiration and over-exhaustion of the patient were induced. Treatment for a few days only was sufficient to cure the patient. No definite pathological and haematological findings are recorded in these cases to warrant any definite conclusion as to its real antimalarial properties. Goodson, Henry and Macfie (1930) tried the alkaloids of both *A. scholaris* and *A. constricta* in bird malaria. The former contains the alkaloid echitamine, which produces only slight action even in doses of 5 mg. *A. scholaris* is reputed to be a valuable remedy in chronic diarrhoea and in advanced stages of dysentery. The report of the Indigenous Drugs Committee states that the drug seems to produce good effects in cases where the catarrhal conditions of the mucous membrane of the intestines have lasted for some time. It does not seem to produce any marked effect in ordinary diarrhoea. A tincture prepared by the Medical Stores Depot at the recommendation of the Indigenous Drugs Committee was tried clinically in three cases of dysentery in the jail. No good effects were noticeable from one drachm dose 3 times a day, in any of the cases. According to Mukerjee, Ghosh and Siddons (1942) the total alkaloids (0.3 per cent.) isolated from *A. scholaris* and also a tincture (1 in 10) made from the powdered bark have, contrary to popular belief and earlier records of clinical trials with the drug, little or no demonstrable action in malaria induced in monkeys, or naturally occurring in the

human patients. They have further shown that it exercises no synergistic action on quinine. The drug, however, is of value as a febrifuge.

References:—

(1) Bacon, R. F., 1906, *Jour. Sci. Philippines*, 1, 10, 1007; (2) *Report, Indigenous Drugs Committee*, 1921; (3) Goodson, J. A., Henry, T. A., and Macfie, J. W. S., 1930, *Biochem. Jour.* 4, 874; (4) *Ind. For. Leaflet* No. 70, 1944, 4; (5) Goodson, J. C. S., 1925, 1640; (6) Siddappa, 1945, *J. Mysore, Univ.*, 5, 63; (7) Keogh Patricia and Shaw, F. H., 1943, *J. Exptl. Biol. Med. Sci. Australia*, 21, 183; (8) Mukerjee, Ghosh, and Siddons, 1942, *Ind. Med. Gaz.*, 723; (9) Brown, G. L. 1938, *J. Physiol.*, 92.

ANDROGRAPHIS PANICULATA Nees. (Acanthaceæ)

THE CREAT

VERN.—Arab.—*Qasabhuva*, *Qasabuzzarirah*; Beng.—*Kalmegh*, *Mahatita*; Dec.—*Charayetah*, *Kalaphnath*; Eng.—*Creat*; Guj.—*Kariyat*, *Kiryata*, *Kiriyati*, *Olikiriyata*; Hind.—*Charcyetah*, *Kiryat*, *Mahatita*; Mal.—*Kiriyattu*, *Nalaveppu*; Mar.—*Olenkirayat*; Pers.—*Nainchavandi*; Sans.—*Bhunimba*, *Kirata*; Tam.—*Nilavembu*, *Shiratkuchi*; Tel.—*Nelavemu*.

It is an annual plant, 1-3 ft. high, common in hedge-rows throughout the plains of India from Lucknow to Assam. It is also cultivated in gardens in some parts of India. The herb is well-known under the name of 'kalmegh' and forms the principal ingredient of a household medicine called 'alui' which is extensively used in Bengal. The macerated leaves and juice together with certain spices are made into little globules, which are prescribed for infants to relieve griping, irregular stools and loss of appetite. The roots and leaves have also the reputation of being a febrifuge, tonic, alterative and anthelmintic. In general debility, dysentery and certain forms of dyspepsia associated with gaseous distension of the bowels, the decoction or infusion of the leaves have been used with satisfactory results.

CHEMICAL COMPOSITION.—Dymock and his co-workers found that an aqueous infusion of the herb was intensely bitter and acid and thought that the bitterness was due to an indifferent, non-basic principle. No alkaloid could be isolated but the ash contained a large quantity of potassium salts. Gorter (1911) thought that the bitter substance in the leaves was a lactone 'andrographolid' of the formula, $C_{20}H_{30}O_5$. Later investigations by Bhaduri (1914) showed that the leaves contained two bitter substances and traces of an essential oil. The first bitter principle obtained as intensely bitter yellow crystals with formula, $C_{19}H_{28}O_5$, and m.p. 206° . It did not respond to any tests for alkaloids and glycosides. The second bitter substance was obtained in an amorphous form and was named 'kalmeghin', $C_{19}H_{51}O_5$, m.p. 185° .

THERAPEUTIC USES.—A preparation of this drug was sometime ago largely advertised in England as a substitute for quinine and as a general powerful tonic. This has, however, been largely discontinued as it does not seem to possess any special antimalarial property. It is an intensely bitter substance and seems to be in no way inferior to other bitters mentioned in the pharmacopoeia. It is easily available and is very cheap and merits better recognition.

References:—

(1) Gorter, 1911, *Rec. Trav. Chim. Pays-Bas*, 30, 151; (2) Bhaduri, 1914, *Amer. Jour. Pharm.*, 86, 349.

ANTIARIS TOXICARIA Lesch. (Moraceæ)

THE UPAS TREE

VERN.—Bomb.—*Chandkuda*, *Chandla*, *Chandul*, *Charvarmada*, *Jassoond*, *Karvat*, *Kharwat*; Eng.—*Upas tree*; Mal.—*Arayannali*, *Nettavil*; Mar.—*Chandkuda*, *Chandkura*, *Chandla*, *Charvarmada*, *Karvat*, *Kharwat*; Sans.—*Valkala*; Tam.—*Ali*, *Arandali*, *Irainji*, *Maravuri*, *Nettavil*, *Pattai*.

The tree has become famous since the latter part of the eighteenth century as the source of a most deadly poison. Most exaggerated statements regarding this plant were circulated by a Dutch surgeon about that period. It was stated that all living things approaching within miles of these trees fall a victim to the effects of the poison exhaled from them. These are now universally recognised to be myths and not facts. The juice derived either from the leaves or the bark of the tree is nevertheless distinctly poisonous. The sap is of a dark brown colour with a gummy consistency, bitter and biting in taste. It is used to this day as an arrow poison by the Karens in Java, Malaya and particularly in Burma where the tree is most commonly found. Its poisonous properties, however, are not widely known in the Deccan and Ceylon where also the tree is frequently met with. In the Concan and in Canara, the bitter seeds are used as a febrifuge and as a remedy in dysentery, one-third to one-half of a seed being given three times a day. In Travancore, *A. toxicaria* is known as the 'sacking tree' and is not regarded by the people as poisonous; the same is the case in Coorg, where sacks and even garments are sometimes made from the inner bark.

CHEMICAL COMPOSITION.—A large amount of work has been done on the composition of the milky juice of this plant since 1838. The latest by Kiliani (1913), shows that the juice contains the following important constituents: (1) Amiarol, $C_9H_{12}O_4$, the trimethyl ether of 1,2,3,5 phenetrol, (2) potassium nitrate, in large amounts, (3) a crystalline resin, named antiarresin, $C_{39}H_{56}O_2$, which is the cinnamyl ester of α -amyrin, (4) a crystalline protein, (5) an acid, $C_{16}H_{14}O_7$ and (6) three active glycosides (*a*) α -antiarin, $C_{72}H_{12}O_{10.4}H_2O$, crystalline, M.P. 220-225°, (*b*) β -antiarin, $C_{27}H_{38}O_{10.3}H_2O$, crystalline, M.P. 206-207° and (*c*) γ -antiarin which is amorphous. These glycosides occur in varying amounts in different samples and are said to possess strong digitalis-like action on the heart.

PHARMACOLOGICAL ACTION.—Regnault (1878) experimented with a juice supposed to have been derived from *A. toxicaria* and concluded that it was a powerful heart poison. Boinot and Hedon (1891) examined the arrow poison prepared by the Maungs of Tonking from the leaves of *A. toxicaria*. The dried latex was a dark thick plastic substance which forms an emulsion in water and normal saline, leaving behind a gummy residue. It dissolved slowly in alcohol making a white opaque solution. Three drops of a solution of 0.5 gm. of the poison in 10 gm. of water placed on a frog's heart arrested the pulsations in 7 minutes. About 10 minutes after the injection of a toxic dose of a 2 per cent. solution in a guinea-pig weighing 250 gm., the animal became very quiet and had a tendency to avoid all movements. On making it move, it dragged its hind limbs in a way that showed marked paresis. Soon after, it developed tremors of the head and was unable to raise it. Later, the front limbs lost all strength with the result that the animal lay on its abdomen with legs outstretched. Urine and faeces were expelled after some spasms and the animal died. The minimum lethal dose was found to be 1/40 gr. of the actual poison in solution. A dose smaller than this produced mild symptoms but the animal recovered completely in about 8 hours. No

haemorrhages were seen anywhere in the body on post-mortem examination excepting a faint redness at the site of the injection. A solution of 0.4 gm. of the substance in 25 c.c. of absolute alcohol is opalescent; 2 c.c. of this injected into a guinea-pig produced death of the animal in 15 minutes. The remaining portion of the solution was dried and weighed. The approximate quantity of the drug in the alcoholic solution which killed the animal was found to be 0.13 gm. (1.95 gr.). Two more guinea-pigs of the same weight who received 1 c.c. remained ill for about half an hour and then recovered completely. As the lethal dose calculated from the emulsion in water was 1/40 gr. and in alcohol 1.95 gr., it is evident that the poisonous element is not the alcohol-soluble portion only, but something more than that. The cause of death as a result of administration of the drug in experimental animals seems to be failure of the heart. The heart is found on post-mortem examination to be contracted and in systole.

Pharmacological studies carried out in the School of Tropical Medicine show that the drug is a very powerful heart poison. 10 to 15 mg. of the water-soluble fraction injected intravenously in a cat usually produces a fall of blood pressure followed quickly by death due to auricular and ventricular fibrillation. That the heart is primarily affected is shown by the fact that the cardiac failure usually precedes the failure of respiration. The alcohol-soluble fraction seems to be less potent than the watery extract. Further work has shown that the dried juice from *A. toxicaria* has a slight stimulant action on the heart and circulation. In larger doses it acts as a strong cardiac poison. The action on the auricle is much stronger than that on the ventricles. The drug acts mainly on the myocardium. It may also have some effect on the termination of the vagi as it was observed that administration of atropine before the drug reduced its slowing effect on the heart. It has no action on the higher centres because the drug acts equally well both in intact and decerebrated animals. The drug produces a marked tonic contraction of the isolated as well as the intact intestines and uterus in animals.

THERAPEUTIC USES.—The drug has for centuries been avoided as a deadly poison and in view of recent investigations, there appears to be ample justification for the popular belief regarding its toxicity. It is, however, a potent remedy and it may be possible after more detailed study of its pharmacological properties, to regulate its dosage in such a way that it may be used as a therapeutic agent. There are many examples of potent remedies and poisons which are being used in therapeutics to the immense benefit of suffering humanity.

References:—

- (1) Kiliani, H., 1896, *Arch. Pharm.*, 234, 438; (2) Kiliani, H., 1910, *Ber.*, 43, 2574; (3) Kiliani, H., 1913, *Ber.*, 46, 2179; (4) Chopra, R. N., and De, P., 1934, *Ind. Jour. Med. Res.*, 21.

ARECA CATECHU Linn. (Palmæ)

THE ARECA- OR BETEL-NUT PALM

VERN.—Arab.—*Fofal*, *Fufal*; Assam.—*Tambul*; Beng.—*Gua*, *Supari*; Dec.—*Supari*, *Supyari*; Eng.—*Areca-nut palm*, *Areca palm*, *Betel nut palm*, *Betel nut tree*, *Betel palm*, *Cashoo nut tree*, *Catechu palm*, *Catechu tree*, *Drunken date tree*, *Fasel nut*, *Fausel nut tree*, *Medicinal cabbage tree*,

Indian nut tree, Pinang palm, Supari palm; Guj.—*Hopari, Phophal, Sopari*; Hind.—*Supari, Suppari, Supyari*; Mal.—*Atekka, Chempalukka, Ghonta, Kalunnu, Kamuka, Kavunnu, Kazhangu, Khhapuram, Kramukam, Pakka, Pugam*; Mar.—*Pophali, Pung, Supari*; Pers.—*Girdchob, Popal, Pupal*; Sans.—*Akota, Chhataphala, Chikkana, Dirghapadapa, Dridhavalakala, Ghonta, Gopadala, Guvaka, Kapitana, Karamatta, Khapura, Kramuka, Puga, Pugi, Rajatala, Tambula, Tantusara, Valkataru*; Tam.—*Kamugu, Kandi, Kiramugam, Kugagam, Pakku, Pakkupanai, Pugam, Tuvar kav*; Tel.—*Chikinamu, Chikini, Gautupoka, Kolapoka, Kramukamu, Oppulu, Oppuvakkulu, Poka, Prakka, Pugamu, Vakka*; Urdu.—*Supari*.

A. catechu is a handsome palm with a tall, slender graceful stem crowned by a tuft of large elegant-looking leaves. The tree is indigenous to Sunda Islands but is now extensively cultivated in most tropical countries, especially southern India, Assam and the Eastern Archipelago. In these parts the seeds are universally employed by the inhabitants as a masticatory. These are chewed together with lime, black catechu and the leaves of betel (*Piper betle*), and sometimes also with such articles as turmeric and tobacco leaf. The popular belief is that decay of teeth is prevented, but owing to constant irritation the mucous membrane of the mouth and gums is inflamed causing loosening and loss of teeth, and sometimes oral carcinoma. The fruit is orange-yellow in colour when ripe and is of the shape and size of a small egg. The pericarp is fibrous resembling that of a coconut; when ripe it can be separated easily from the seed. The seeds when dry are 20 to 25 mm. in diameter and bluntly conical in shape, greyish brown in colour and silvery in appearance. The surface is covered with a network of paler depressed lines. The seed is hard and heavy and has an aromatic, astringent and somewhat acrid taste.

CHEMICAL COMPOSITION.—The first chemical analysis of the seed was performed by Bombelon in 1886 who isolated a liquid volatile alkaloid resembling nicotine to which he gave the name *arecaine*. Later, other alkaloids were isolated, the proportions of these in the seeds being *arecaine* 0.1 per cent. and *arecoline* 0.07 to 0.1 per cent.; *arecaine*, *guvacoline*, *guvacine* and *choline* occur only in traces. All these alkaloids are chemically related; arecoline is methyl arecaine and is prepared by esterifying arecaine with methyl alcohol; arecaine is prepared by the action of formaldehyde and formic acid on guvaccine; guvaccine can be converted into guvaccine by hydrolysis. Besides these, the seed contains 15 per cent. of tannin and 14 per cent. of fat. The most important of all the alkaloids and the one to which the sialagogue and the anthelmintic properties of the drug are attributed is arecoline, which has the formula $C_8H_{13}NO_2$. It is a colourless, oily liquid with a boiling point of $230^{\circ}C$. It forms crystalline salts with acids, and arecoline hydrobromide is official in several pharmacopoeias in Europe. On account of the readiness with which this alkaloid is absorbed it is usually considered too dangerous to be used as a taeniocide in pure conditions and therefore the powdered nut is preferred.

PREPARATIONS.—Dry powdered seeds are given in doses of 1 to 4 dr. Powdered fresh seeds are more powerful in doses of 2 to 4 dr. Arecoline hydrobromide is official in the German Pharmacopoeia and in the French Codex; the dose is approximately 1/20 to 1/40 gr. (0.003 to 0.0015 gm.). It is a crystalline substance and is soluble in water. It occurs in 'taenaline' which is a liquid preparation used in veterinary medicine; dose 1 minim. for every pound weight in dogs.

PHARMACOLOGICAL ACTION.—Arecoline is a highly toxic substance. Its pharmacological action resembles that of muscarine, pelletierine and pilocarpine. It violently stimulates the peristaltic movements of the intestines and produces a marked constriction of the bronchial muscles which can be overcome by adrenaline or atropine. The terminations of the vagi in the heart are stimulated and the organ is depressed; the blood pressure falls. When dropped into the eye, a 1.0 per cent. solution constricts the pupil, like physostigmine. It is a powerful sialagogue and stimulates the secretion of sweat in the same way as pilocarpine. The arecaidine hydrochloride exerts no marked effect on isolated frog's heart or rabbit's intestine or uterus. The arecaidine methylchloride depresses the isolated frog's heart but stimulates the rabbit's intestine and uterus. This action is prevented by the use of atropine sulphate. The action of this salt is weaker than that of arecoline hydrochloride.

THERAPEUTIC USES.—In India and China, areca or betel nut has been used as an anthelmintic in man and animals from time immemorial. It was considered so efficacious against tapeworms and roundworms and so highly esteemed by the people that it was introduced into the British Pharmacopoeia. Barclay tried the powdered seeds in doses of 6 dr. against tapeworms with good results. Powell found betel nut and the juice of the leaves of *Piper betle* in doses of one ounce an efficient anthelmintic. He thought so highly of its anthelmintic properties that he expressed the opinion that the habit of chewing betel nut among the inhabitants of certain countries where intestinal parasites are common, is a protective habit instinctively acquired on account of its prophylactic value against these parasites. Waring, however, was of the opinion that it could hardly have any such effect, as intestinal parasites are very common among the people of India and Burma who make a habit of chewing betel nut. Chopra and Chandler (1928) believe that the chewing of betel nut and betel leaf does influence the number of hookworms harboured. This result is not, however, attributable to any anthelmintic power of the juice, which is not swallowed, but to the constant spitting which tends to eliminate the immature hookworms while making their way from the trachea to the oesophagus. The chewing of tobacco has a similar effect, and in some places is credited with anthelmintic power. Bentley (1904) and Schuffner (1912) treated a number of cases of hookworm disease with half to one ounce doses of the powdered betel nuts with little effect. Caius and Mhaskar (1924) gave four drachms of the recently-dried seeds in the form of a powder without any preliminary preparation and without any after purgative in cases of roundworm and hookworm infections. The patients passed 1 to 3 semi-solid stools but no worms were expelled. The powdered fresh nut produced a stronger irritant effect on the intestine but no worms were expelled.

Areca nut is further credited with astringent properties and has been used with satisfactory results in the relaxed condition of the bowels which sometimes occurs in tropical climates. Large doses, e.g. 6 dr. to 1 oz. of the powdered seeds, however, produce griping and irritation and loose motions may start as a result of such irritation.

References:—

(1) Chopra, R. N., and Chandler, A. C., 1928, *Anthelmintics and their Uses in Medical and Veterinary Practice*, The William Wilkins & Co., Baltimore; (2) Lewin, L., 1931, *Phantastica*; (3) Chu Kadonaga, 1940, *Folia Pharmacol. Japan*, 57.

ARGEMONE MEXICANA Linn. (Papaveraceæ)

MEXICAN POPPY

VERN.—Beng.—*Baroshialkanta*, *Shialakontha*, *Shialkanta*, *Siakanta*; Dec.—*Bharamdandi*, *Daruri*, *Piladhatura*, *Farangidhatura*; Eng.—*Mexican poppy*, *Prickly poppy*, *Yellow Mexican poppy*; Guj.—*Darudi*; Hind.—*Bharbhand*, *Biladhutura*, *Brahmadundi*, *Brahmi*, *Farangidhutura*, *Satiyanashi*, *Shialkanta*, *Ujarkanta*; Mal.—*Brahmadanti*; Mar.—*Daruri*, *Firangi dhotra*, *Kantedhotra*, *Kontedhotra*, *Pinvala dhotra*; N. W. Prov.—*Bharbhurwa*, *Kantela*, *Karwah*; Punj.—*Bhatkatcya*, *Bhatmil*, *Bherband*, *Kandiari*, *Katsi*, *Satyanasa*, *Sialkanta*; Sans.—*Brahmadandi*, *Hemadugdha*, *Hemashikha*, *Hemavati*, *Hemavha*, *Srigalakanta*, *Tiktadugdha*, *Yavachincha*; Tam.—*Bramadandu*, *Kurukkum*; Tel.—*Brahmadandi*.

It is an American plant, which has become naturalised in India, and grows wild all over the country. It is a spiny herbaceous annual, found everywhere from Bengal to the Punjab, on the roadside and on waste lands. The leaves are prickly and thistle-like; the flowers have a bright yellow colour. The yellow milky juice of the plant has long been used in India as a medicine for dropsy, jaundice and cutaneous affections. An infusion of the juice was regarded by early physicians as a diuretic and was fairly extensively used. As an external application for indolent ulcers and herpetic eruptions, it was also popular. The seeds yield on expression a pale yellow clear limpid oil used in lamps and medicinally in ulcers and eruptions. The early European physicians in India used the seeds and seed-oil as a remedy for dysentery and other intestinal affections. There has been much difference of opinion regarding the aperient action of the oil but some authorities assert that the oil in doses of 30 to 60 minims is a valuable remedy.

CHEMICAL COMPOSITION.—In 1863 Haines examined the extract of the whole plant and was unable to find any alkaloid in it. Later investigations, however, showed that it contained *berberine* and *protopine* but no morphine or argemone as was reported by some workers. The seeds yield about 22 per cent. of an oil—argemone oil. This oil contains up to 40 per cent. free glycerides of fatty acids. Dragendorff stated that the seeds contained an alkaloid which agrees with morphine in all its important reactions, but this statement is not borne out by recent studies. The seeds when incinerated yield an ash which is largely composed of alkaline phosphates and sulphates. After saponification of argemone oil with alcoholic potassium hydroxide and dilution of the mixture with water a white substance separates in shining mica-like crystals, $C_{18}H_{15}O_4N$, m.p. $188-9^{\circ}C$. An apparently identical compound is obtained as the hydrochloride by passage of dry hydrochloric acid gas through the oil. This gives a free base which, after precipitation from hot toluene by hot absolute alcohol, melts at $190^{\circ}C$. These preparations give many of the reactions characteristic of alkaloids. They are not obtainable in good yield from argemone oil which has been rendered nontoxic by exposure to light.

THERAPEUTIC USES.—As has already been stated, the oil obtained from the seeds has long been used as a purgative. Though it produces an aperient action it has no special advantage over the other purgative drugs of the pharmacopoeia and hence is not used to any large extent in these days. The seeds are said to possess narcotic properties but these are not very marked.

Chopra and Co-workers (1940) showed that argemone oil produced symptoms resembling those of epidemic dropsy. An outbreak studied showed that those using mustard oil adulterated with argemone oil were mostly attacked. No fresh case occurred after the use of adulterated oil was stopped. The nitric acid test for detection of argemone oil as adulterant was evolved.

The nitric acid test for argemone oil:

1. Take 2 c.c. of the sample of oil to be tested.
2. Add an equal quantity of strong nitric acid.
3. Shake for about half a minute.
4. Note any change in colour in the lower or in the nitric acid layer.
5. If the bottom layer shows a brownish to an orange colour regard the specimen as suspicious and reject it as unsafe for use.

False positive reactions may be given by certain other adulterant oils such as sesame oil, ground-nut oil, etc.

The substances responsible for this reaction have been isolated in pure form and have an empirical formula, $C_{19}H_{15}O_4N$.

References:—

(1) Iyer, Sudborough and Ayyar, 1925, *J. Ind. Inst. Sci.*, 8, 29; (2) *Bull. Imp. Inst. Lond.*, 1922, 20, 292; (3) Mukerjee, S. P., Lal, R. B., and Mathur, K. B. L., 1941, *Ind. Jour. Med. Res.*, 361; (4) Chopra, R. N., Pasricha, and Banerjee, K., 1940, *Ind. Med. Gaz.*, 262.

ARISTOLOCHIA INDICA Linn. (Aristolochiaceæ)

VERN.—Arab.—*Zaravandehindi*; Beng.—*Isarmul*; Bomb.—*Kadula*, *Sampsum*, *Sapasan*, *Sapshi*; Eng.—*Indian birthwort*; Hind.—*Isharmul*; Mal.—*Eswaramulla*, *Garalavegam*, *Isvaramuli*, *Karukkapallu*, *Katalivegam*, *Perumarunna*, *Perunkilannu*; Mar.—*Sapasan*; Pers.—*Zaravandehindi*; Sans.—*Ahigandha*, *Arkamula*, *Ishvara*, *Ishvari*, *Nakuleshtha*, *Sunanda*; Tam.—*Adagam*, *Isadesatti*, *Isuraver*, *Karudakkodi*, *Perumarundu*, *Perunkilangu*, *Sarsugadi*, *Talaichuruli*; Urdu.—*Shapesand*.

It is a twining perennial plant growing all over the tropical region of India, Bengal, Konkan, Travancore and the Coromandel Coast. The drug as sold in the bazar consists of the root and stem, the latter constituting by far the largest portion. The root tastes very bitter and possesses a characteristic aromatic odour. It is chiefly used in the treatment of bowel complaints in children and in intermittent fevers. The roots possesses emmenagogue and antiarthritic properties and is held in much esteem as stimulant and tonic. The root and leaves are said to be valuable antidote against the bites of snake and poisonous insects. Mhaskar and Caius (1931) however, found that the plant has no antidotal properties or therapeutic effect against cobra venom. The drug is official in the Indian Pharmacopoeial List and a tincture prepared from this is recommended for use.

CHEMICAL COMPOSITION.—The only mention of the early chemical study of *A. indica* in literature occurs in *Pharmacographia Indica*. The work was of very preliminary nature and only indications of the presence of a basic substance and of a yellow resin were obtained. Krishnaswamy and co-workers (1935) investigated the roots and obtained (a) an essential oil which is responsible for the characteristic odour of the roots. The oil consists mostly of high boiling constituents and owing to its feeble volatility with steam the higher fractions are obtained in the unsaponifiable matter extracted with petroleum ether. It contains three per cent. of carbonyl compound which possesses odour of iso-vanillin; it has new sesquiterpinoid compounds; a small quantity of camphor was also found to occur in it. A sesquiterpene, Ishwarene, a sesquiterpene ketone Ishwarone and sesquiterpene alcohol Ishwarol have been isolated. The names are derived from the Kannada name of the roots Ishshwari beru. Ishwarene is a mobile colourless liquid, b.p. 130-32°C. at 10 mm. Ishwarone is a sesquiterpene ketone, it is a fairly mobile colourless liquid, b.p. 118-20°C. at 1 mm. and possesses formula, $C_{15}H_{22}O$. Ishwarol is a pale yellow viscous oil and is found to be sesquiterpene alcohol of the formula, $C_{15}H_{23}OH$. (b) A fixed oil which is made up of the glycerides of palmitic, stearic, lignoceric, cerotic, oleic and linolic acids. A considerable amount of sitosterol a small quantity of the glycoside of phytosterol melting at 146°C. and ceryl alcohol were isolated from the unsaponifiable matter. (c) The roots are found to contain a very bitter yellow compound sparingly soluble in most of the usual organic solvents. This has the formula, $C_{17}H_{11}O_7N$, and is not identical with any of the compounds isolated from other species of Aristolochiaceæ family. It has been named isoaristolochic acid. (d) From the basic constituents a new alkaloid aristolochine, $C_{17}H_{18}O_3N$, a crystalline powder, m.p. 215°C. was isolated. (e) The roots have also been found to contain considerable amount of reducing sugars and allantoin.

PHARMACOLOGICAL ACTION.—Aristolochine causes cardiac and respiratory paralysis in frogs and mice, (Ryo 1927). It exerts some pressor action and increases the rate of respiration in rabbits. Skeletal muscle is stimulated by small doses and paralysed by large doses. In rabbits it causes haemorrhagic nephritis and arsenical-like gastro-intestinal irritation in dogs. It is used in medicine solely as a bitter tonic. More work on the pharmacological action of the active principle as well as its therapeutic application is indicated.

References:—

(1) Mhaskar and Caius, 1931, *Ind. Med. Res. Memoirs*, 19; (2) Dymock, Warden and Hooper, 1893, *Pharmacographia Indica*, 158; (3) Krishnaswamy, Manjunath, and Rao, 1935, *J. Ind. Chem. Soc.*, 476, 494; 1937, 39; (4) Ryo, 1927, *Folia Pharmacol. Japan*, 4, 123.

BALSAMODENDRON MUKUL Hook. (Burseraceæ)

GUM GUGUL

VERN.—Sans.—*Guggula*; Beng.—*Guggul*, *Mukul*; Hind.—*Gūgal*; Tam.—*Gukkal*; Guj.—*Gūgal*; Arab.—*Moql*.

The plant *B. mukul* Hook. belongs to the family *Burseraceæ* and is synonymous with *Commiphora mukul* Engl. It is a small tree, about 4 to 6 ft. high, with small brownish flowers, slightly ascending branches and alternate trifoliate leaves. It grows in the arid zones of Rajputana, Khandesh, Sind, Kathiawar, East Bengal and Assam. The oleo gum resin from the plant, known in Sanskrit as Koushikana or Guggulu and in Bengali and Hindi as Guggul, is obtained by incision of the bark during the cold season. The gum resin is brown or sometime dull-green in colour and has a bitter taste with an aromatic odour. It is used as a demulcent, aperient, carminative and alterative. It is stated to be

useful in leprosy, rheumatism, syphilitic disorders, scrofulous affections, nervous and skin diseases and in urinary disorders. An ointment prepared from the gum resin is used in the treatment of chronic ulcers, it is considered particularly effective in the treatment of Delhi sores (Watt, 1889-96).

CHEMICAL COMPOSITION.—There seems to be no record of any detailed chemical examination of this gum resin. The constituents of the gum resin from an allied plant, *Commiphora myrrha* Holm. (Syn. *B. myrrha* Nees) are stated to be: gums 40 to 60 per cent., essential oil 2.5 to 10 per cent. resins 27 to 50 per cent., bitter substance, etc. The constituents of balsam of tolu have been found to be about 7.5 per cent. of oily aromatic liquid consisting mainly of benzyl benzonate and a small proportion of benzyl cinnamate, about 3 per cent. of impurities, about 0.05 per cent. of vanillin, about 12 to 15 per cent. of free cinnamic acid and benzoic acid, the latter being present in smaller amounts. The resin is present as an ester which on hydrolysis gives cinnamic acid and a little benzoic acid and a resin alcohol toluresinotannol, $C_{17}H_{18}O_5$, (Oberlander, 1894). The gum resin of *B. mukul* was investigated by Ghosh (1942) and was found to contain about 4.65 per cent. of foreign impurities, 32 per cent. of gum, 19.5 per cent. of mineral matter consisting chiefly of SiO_2 , Ca, Mg, Fe, and Al. It contains about 1.45 per cent. of an essential oil having a faintly aromatic odour. The presence of benzoic acid, cinnamic acid, benzyl benzonate or vanillin which form important constituents of Balsam of Tolu, could not be detected in *B. mukul*. Besides a very small amount of saponifiable resin, the Balsam contains resins, which could not be saponified. The results indicate that *B. mukul*, which does not contain the constituents of the Balsam of Tolu, could not be recommended as a substitute for the latter. He further investigated the resins, determined the percentage of free acids, combined acids, saponification value, acid value, ester value, percentage of essential oil, ash, etc., in the resin and in the ethereal extract of these. The values as determined by him are given below along with those of balsam of Tolu.

		Tolu Balsam	<i>B. mukul</i> (Guggul)	Ethreal Extract Guggal
Free acid per cent.	.....	7.1 to 16.3	Traces	—
Combined acid per cent.	.....	19.4 to 37.7	—	—
Acid value per cent.	.....	111.3 to 126	9.74	4.20
Ester value per cent.	.....	70.0 to 88.1	50.66	59.9
Saponification value per cent.	.....	188.6 to 204.3	60.3	64.1
Saponification value of ethereal extract per cent.	.....	274.4 to 301.8	—	—
Gum per cent.	.....	—	32.4	—
Specific rotation	.....	—	—	26.3°
Essential oil per cent.	.....	0.2	1.45	—
Ash per cent.	.....	—	19.40	—

Bhati (1950) investigated the essential oil from the resin of the plant and found that the chief components of the essential oil are 64 per cent. myrcene, 11 per cent. dimyrcene and some polymyrcene.

PHARMACOLOGICAL ACTION.—The pharmacological action of this oleo-resin resembles in many ways the action of copaiba and cubebs. It has no action on the unbroken skin, but on the abraded skin and on the mucous membranes, it acts as an astringent and antiseptic. When taken internally it acts as a bitter, stomachic and carminative, stimulating the appetite and improving the digestion. It produces a sensation of warmth in the stomach and is quickly absorbed. Like all oleo-resins it causes an increase of leucocytes in the blood and stimulates phagocytosis. It is excreted by the skin, mucous membranes and the kidneys, and in the course of its excretion, it stimulates them and disinfects their secretions.

It acts as a diaphoretic, stimulating expectorant and diuretic. It is also said to be a uterine stimulant and an emmenagogue, and regulates the menstrual functions. It is quite harmless and may be taken for a long time without any ill effects. It sometimes produces an erythematous rash like copaiba, and rarely symptoms of kidney irritation may appear, but these rapidly disappear when the drug is omitted.

THERAPEUTIC USES.—This drug has a wide range of usefulness in the indigenous medicine. It is used in form of a lotion for indolent ulcers, and as a gargle in caries of the teeth, weak and spongy gums, pyorrhoea alveolaris, chronic tonsillitis and pharyngitis and ulcerated throat. A drachm of the tincture (20 per cent. in 90 per cent. alcohol) in 10 oz. of water makes a useful lotion and gargle. It is used as a stomachic in chronic dyspepsia with dilatation and atony of the walls of the stomach. Troublesome borborygmi are often relieved by the use of this oleo-resin. As an intestinal disinfectant it is used in chronic catarrh of the bowels, diarrhoea, chronic colitis, tubercular ulceration of the bowels and diarrhoea. It is believed to stimulate the appetite, improves the general condition, reduces fever, causes absorption of effused products and reduces secretion from diseased surfaces. In pulmonary tuberculosis it stimulates expectoration, and lessens and disinfects the sputum. In pleural effusions and in ascites of tubercular peritonitis it is said to be of great value. In marasmus of children it is said to be of value and is also used in anaemia, neurasthenia, debility and allied conditions. It is believed to be a valuable aphrodisiac. Gugul is said to have marked antispurative properties. Given in large doses every four or six hours it is believed to be useful in laryngitis, bronchitis, pneumonia and whooping cough. It is often combined with salicylate of sodium. It is said to improve the general condition of the patient in leprosy, relieves lassitude, gives a sense of well-being, and relieves the nervous pains that are so very common in this disease. In pyelitis, cystitis, and gonorrhoea it is useful after acute symptoms have subsided. In chronic endometritis, amenorrhoea, and menorrhagia it is particularly valued. Administered in large doses it is said to be useful in leucorrhoea. Inhalations of the fumes of burnt gugul are given in hay fever, acute and chronic nasal catarrh, chronic laryngitis, chronic bronchitis, and phthisis.

The beneficial effects of the drug in many of these conditions can be explained by the presence of the oleo-resin which contains active aromatic substances.

References:—

(1) Finnmere, 1926, *The Essential Oils*; (2) Roberts, 1931, *Vegetable Materia Medica of India and Ceylon*; (3) Dieterich, 1928, *Analysis of Resins*; (4) Oberlander, 1894, *Arch. Pharm.*, 232, 559; (5) Watt, 1889-96, *A Dictionary of the Economic Products of India*, 1; (6) Wehmer, 1931, *Die Pflanzenstoffe*, II, 649; (7) Chopra, R. N., Dutta, A. T., and Ghosh, S., 1942, *Ind. Jour. Med. Res.*, 331; (8) Ashram Bhatl, 1950, *J. Ind. Chem. Soc.*, 436.

BAMBUSA ARUNDINACEA Willd. (Gramineæ)

SPINY BAMBOO

VERN.—Arab.—*Qasab*; Assam.—*Bnah*, *Kata*, *Koto*; Beng.—*Bans*, *Behurbans*; Bomb.—*Dougi*, *Kalak*, *Mundgay*, *Padhai*; C. P.—*Katang*; Eng.—*Spiny bamboo*, *Thorny bamboo*; Hind.—*Bans*, *Kantabans*, *Katang*, *Magarbans*, *Malbans*; Mad.—*Penteveduru*; Mal.—*Illi*, *Kampu*, *Karmmaram*, *Mulmulam pattil*, *Tejanam*, *Trinadhvajam*, *Venu*; Mar.—*Kallak*; Pers.—*Nai*; Sans.—*Bahupallava*, *Brihatrina*, *Dhanurdruma*, *Dhatushya*, *Dridhagranthi*, *Dridhapatra*, *Kamatha*, *Kantaki*, *Kaemmara*, *Kichaka*, *Kilati*, *Kishkupa*, *Maskara*, *Mrityubija*, *Navagragandha*, *Suparvan*, *Trindhvaja*,

Trinaketu, Vansha, Venu, Yavaphala; Tam.—*Ambal, Ambu, Iraivarai, Kambul, Kuluaimungil, Masukkaram, Miruttusam, Mullumungil, Mundul, Palandam, Panai, Peruvarai, Tumbu, Vannigarupam, Varaimungil, Netti, Velam, Veral, Veyal, Vindil*; Tel.—*Bongu, Bonguveduru, Kichakamu, Maskaramu, Mudusuveduru, Pentiveduru, Vajamu*; Urdu.—*Bansa*.

This is a tall, thorny bamboo with a thick central root and stocks. It grows wild throughout the greater part of the country particularly in the hill forests of western and southern India ascending upto an altitude of 3,000 ft. in the Nilgiris. It also occurs in the warmer parts of Ceylon and Burma. This plant has a rapid growth and yields paper pulp of very good quality and of great commercial value.

In the Ayurvedic medicine the stem and leaves are considered sour, bitter and useful in diseases of blood, leucoderma and inflammatory conditions. The sprout and seeds are acrid, laxative and are said to be beneficial in strangury and urinary discharges. Tabashir which occurs in the hollow of culms of the plant in form of concretions is considered sweet and cooling and is used against diseases of the blood, tuberculosis bronchitis, asthma and leprosy. In Tibbi Medicine the root is said to be tonic. It is burnt and applied locally to ringworm infections of the skin, to bleeding gums and to painful condition of joints. The leaves are considered emmenagogue. An infusion made from leaves is used as an eye wash. It is also given internally for bronchitis, gonorrhoea and fever. The juice of the flowers is dropped in the ear for earache and deafness. The leaves mixed with black pepper and common salt have been used to check diarrhoea in cattle. A poultice made by pounding the young shoots of the bamboo is considered an efficacious application for dislodgment of maggots from ulcers. The juice is first poured on the vermin, and the ligneous mass is applied and secured by a bandage. The leaves are reported to be given to horses as a remedy for coughs and colds.

CHEMICAL COMPOSITION.—The grains of the plant, which are generally eaten during famine, contain water 11.0 per cent., starch 73.7, albuminoids 11.8, oil 0.6, fibre 1.7 and ash 1.2 per cent. The young shoots contain a cyanogenetic glycoside and are poisonous. The glycoside is hydrolysed by an enzyme also present in the shoots. When they are cut and soaked in water, one quarter of an ounce of raw shoots or slightly larger amount insufficiently cooked can cause death. The young shoots contain 0.3 per cent. of hydrocyanic acid and are lethal to mosquito larvae.

References:—

(1) Lisbora, J. C., 1896, *List of Bombay Grasses*, 138; (2) Bagchi and Ganguli, 1943, *Ind. Med. Gaz.*, 41; (3) Ghose, and Chopra, 1938, *Arch. Pharm.*, 351; (4) Chopra, Badhwar, and Nayer, 1941, *J. Bomb. Nat. Hist. Soc.*, 865.

BERBERINE-CONTAINING PLANTS

The alkaloid *berberine* is well-known in medicine and is widely distributed in the vegetable kingdom. Berberine occurs chiefly in *Berberis aristata* and other members of the family Berberidaceæ. It has been found to occur in the rhizomes and roots of *Hydrastis canadensis* (Ranunculaceæ) to the

extent of nearly 2.5 per cent. It is also present in a large number of plants belonging to the natural orders, Menispermaceæ, Papaveraceæ, and Rutaceæ. In both the Hindu and the Mohammedan medicine, the berberine-bearing plants have been used as diaphoretics and stomachics and in the treatment of many skin diseases. Although berberine-containing plants are largely used in the indigenous medicine in this country, the pharmacological action of berberine has not been fully worked out. Interest has also been recently aroused in this drug on account of its successful use in the treatment of cutaneous leishmaniasis (oriental sore). The alkaloid berberine occurs in a large number of plants of the Berberidaceæ family, growing in the northern and western parts of the Himalayas at an altitude from 1,000 to 4,000 ft. above the sea level. They also grow in Bhutan and in the Nilgiris in the south of India; in the European and American forests they are also to be found.

1. BERBERIS ARISTATA DC. (Berberidaceæ)

VERN.—Arab.—*Aargis*, *Ambarbaris*; Eng.—*Indian barberry tree*, *Turmeric*; Hind.—*Chitra*, *Chotra*, *Darhald*, *Kashmal*, *Kashmar*, *Rasvat*; Mal.—*Maradarisina*, *Maramanjai*; Nepal.—*Chitra*, *Chutro*; N. W. P.—*Chitra*; Pers.—*Chitra*, *Zirishk*; Punj.—*Chitra*, *Kasmal*, *Simlu*, *Sumlu*; Sans.—*Daruharidra*, *Darvi*, *Kata*, *Katankati*, *Kateri*, *Pitadaru*, *Suvarnavarna*; Simla.—*Kammul*, *Kashmal*, *Kaumul*; Tam.—*Mullukala*, *Usikkala*.

The berries are known as 'zarishk' in Hindi and Persian. The extract made from it is known as 'rasaut' in Hindi and is a common household remedy in this country. *B. aristata*, *B. asiatica*, *B. lycium* and *B. vulgaris* are distinguishable with great difficulty and consequently they have been mistaken for each other in most parts of India. Twelve species have been mentioned and hence the vernacular names are probably inaccurate. *B. aristata* grows in the temperate Himalayas at an altitude of 6,000 to 8,000 ft. It has been used in form of an extract under the name of 'rasanjana' or 'rasavanti' and also in form of a decoction. Mohideen Sheriff described it as one of the really few good drugs of the indigenous medicine and brought it to the notice of the medical profession. The root bark is rich in alkaloidal content and was made official in the Pharmacopoeia of India. Berberine is the chief alkaloid present in the roots. Ray and Roy (1941) have shown that berberine can be easily obtained in form of its salts (yield of hydrochloride 2.23 per cent. and of sulphate 3 per cent.) Chakravarty and Co-workers (1950) isolated two alkaloidal chlorides found to be: (1) palmatine chloride, m.p. 204°C. (decomp.), (2) a mixture of palmatine and berberine chlorides, m.p. 165°C. (decomp.). A tincture made from it was used as a bitter tonic, stomachic, cholagogue, antiperiodic and alterative. In malarial fever it was reputed to be efficacious as a diaphoretic and antipyretic like Warburg's tincture. The yellow dye obtained from the root and the stem is of great commercial value; it is reported to be the best yellow dye available in India and its supply is inexhaustible.

2. BERBERIS ASIATICA Roxb.

VERN.—Beng.—*Daruharidra*; Dehra Dun.—*Kingora*; Guj.—*Daruhaldar*; Hind.—*Daruhaldi*, *Sumlu*; Kum.—*Kilmora*, *Kilmoru*; Mar.—*Daruhaldi*; Nepal.—*Chitra*, *Kissie*, *Matekissie*; Pers.—*Darhuld*, *Daruhuld*; Sans.—*Daruharidra*, *Darupita*, *Darunisha*, *Darvi*, *Dvitiyabha*, *Haimavati*, *Haridra*, *Hemakanti*, *Hemkranta*, *Kaliyaka*, *Kamini*, *Karkatini*, *Kashtha*, *Marmmari*, *Nirdishta*, *Pachampacha*, *Parijani*, *Parjaniya*, *Pita*, *Pitachandana*, *Pitadaru*, *Pitadru*, *Pitalvaka*, *Pitika*, *Sihirraga*; Simla.—*Kammula*, *Kashmala*, *Kaumula*.

It grows in the dry valleys of the Himalayas at an altitude of 3,000 to 7,500 ft. It grows in Bhutan, Garhwal and on the Parasnath Hill. The medicinal uses of this species are similar to those of *B. aristata* and it contains berberine in fair quantities.

3. BERBERIS CORIACEA Brandis

VERN.—Simla—*Kashmal*

It is known in the vernacular as *Kashmal* and is a large, erect, thorny shrub growing in the north-west Himalayas at an altitude of 8,000 ft.

4. BERBERIS FLORIBUNDA Hort.

It is an erect shrub 10 ft. high which grows in Nepal and is used in the indigenous medicine for the same ailments for which the other *Berberis* species are employed. The roots contain eight alkaloids namely oxycanthine, berbamine, berberine, epiberberine, palmatine dihydrocorydaline, jatrorrhizine, acid columbamine. Epiberberine which was prepared by Perkin during his synthetical studies on the berberine and cryptopine alkaloids was found to occur in this plant naturally. Several Indian species of *Berberis* have been examined chemically so far but they have not yielded such a large number of alkaloids as this plant has done. Although no detailed pharmacological studies have been carried out the action of these alkaloids it would appear to follow the same lines as berberine.

5. BERBERIS HIMALAICA

It is a shrub with shining yellowish brown, slightly grooved branches. Its occurrence was reported for the first time in Bhutan by Ludlow and Sheriff when they went there for botanical expedition in 1934. Chatterjee, Guha and Das Gupta (1952) examined the bark and isolated berberine (10.03 per cent.), jatrorrhizine (0.01 per cent.) and a small quantity of a new alkaloid limanthine, $C_{27}H_{40}O_6N_2$, m.p. 206–7°C. isomeric with oxycanthine and berbamine. It was obtained in form of a colourless glistening needles from methyl alcohol in 0.08 per cent. yield. This plant belongs to the genus *Berberis* but it has not been used as a household remedy or included in the indigenous materia medica.

6. **BERBERIS INSIGNIA** Hook. f.

A large beautiful holly-like bush, 4-6 ft. high, with well developed internodes. It is native of the humid forests of the eastern Himalayas from Nepal and Sikkim to Bhutan, at altitudes of 8,000-10,000 ft. above the sea level. It occurs plentifully in the neighbourhood of Darjeeling. Chatterjee (1941) reports that the stem bark contains 1.52 per cent. and the root 2.5 per cent. of the total alkaloids, consisting almost entirely of umbellatine, $C_{21}H_{21}O_8N$, m.p. 206-207°C.

7. **BERBERIS LYCIUM** Royle

It grows in dry hot places in the western Himalayas at an altitude of 3,000 to 9,000 ft. from Garhwal to Hazara. Royle in a paper read before the Linnaean Society of London described 'rasaut' as the same plant described by Pliny, and later by the Greeks. The medicinal extract from the root known under the name of 'rasaut' is a very highly esteemed drug in the indigenous medicine. O'Shaughnessy described it as being useful as a febrifuge, carminative and gentle aperient; in haemorrhoids it is used both locally and internally.

There is some difference of opinion as to whether 'rasaut' should be regarded as a special preparation from the root of *B. lycium* only, or from *B. asiatica* or the two together. Most of the preparations offered for sale are derived from a mixture of the two plants; 'rasaut' is a well-known remedy of the indigenous medicine and is prescribed in doses of from 10 to 30 grains with butter in bleeding piles, as a bitter tonic, and as a febrifuge. Mixed with butter and alum 'rasaut' is used as an external application for the eyelids in acute conjunctivitis. With camphor and butter it forms the constituent of an ointment used against acne, pimples and indolent ulcers. It has been found useful in enlargement of the liver and the spleen. Some physicians consider it to be useful in the treatment of gastric and duodenal ulcers. Chatterjee found umbellatine as the chief alkaloid present in this plant.

8. **BERBERIS NEPALENSIS** Spreng.

Syn. *Mahonia nepalensis* DC.

VERN.—Punj.—*Amudanda*, *Chiror*; Nepal.—*Chatri*, *Milkisse*.

It grows commonly on the Outer Himalayas, from the Ravi eastward to Khasia and the Naga Hills and also in the Nilgiris at an altitude of 5,000 ft. It was used to a small extent by the Bhutias and Nagas as a yellow dye. Umbellatine is the chief alkaloid present in this plant.

9. **BERBERIS UMBELLATA** Wall.

It is common gregarious shrub 2-4 feet high, sometimes attaining a height of 8 ft. The twigs and young shoots are reddish and glabrous. The plant occurs in the main Himalayan ranges and in the interior dry ranges (altitude of 9,000-12,000 ft.), from Kashmir eastwards, and from Kumaon to Bhutan. It occurs

in form of patches in openings in blue pine forests, or is scattered over bare southern aspects above forest level. The growth is stunted at high elevations.

Umbellatine was first isolated from the stem bark of this plant (yield 0.68 per cent.) Umbellatine like berberine is not a protoplasmic poison and has a specific inhibitory action on the growth of *Leishmania tropica*, the organism of oriental sore. The alkaloid has a depressant action on the cardio-vascular system. The heart is depressed and the blood vessels are dilated by direct action on the musculature. There is also probably some stimulation of the parasympathetic vasodilator nerve endings. The musculature of the spleen, intestine, uterus and bladder is also stimulated. In some case the action appears to be produced by stimulation of the parasympathetic nerve endings of the muscle concerned. The respiration is depressed and bronchi are constricted.

10. BERBERIS VULGARIS Linn.

THE TRUE BARBERRY

VERN.—Arab.—*Ambar-baris*; Pers.—*Bedana*, *Cutch*; Punj.—*Zirishk*, *Kashmal*, *Chachar*.

It is a deciduous thorny shrub growing in the Himalayas from Nepal westwards, in the shady forests at an altitude of over 8,000 ft. above the sea level. It is used largely in the Punjab as a diuretic for the relief of heat, thirst and nausea. It is considered to be astringent, refrigerant, and antibilious. In small doses it is said to be a tonic, in large doses it acts as a purgative. It was formerly used in jaundice.

OTHER BERBERINE-CONTAINING PLANTS

Besides the various species of *Berberis* just described, a number of other plants used in the indigenous medicine contain berberine. A few of these plants are mentioned below:

1. ARGEMONE MEXICANA Linn. (Papaveraceæ)

This plant contains large quantities of a yellow juice resembling that from gamboge containing small quantities of berberine. (See page 283).

2. COPTIS TEETA Wall. (Ranunculaceæ)

GOLD THREAD

VERN.—Assam.—*Mishmeelæta*, *Tita*; Bomb.—*Mamiran*, *Mishmitita*; Eng.—*Coptis*, *Gold thread*; Hind.—*Mamira*, *Mamiran*, *Mishmitita*; Sind.—*Mahmira*.

This plant is a native of the mountainous regions bordering on Upper Assam and has a reputation as an eye salve. The root, which is dark yellowish in colour and has a bitter taste, was made official in the Pharmacopœia of India. It is sent down to Assam in small baskets with open meshes of narrow strips of bamboo or rattan, each basket containing an ounce of small pieces of the dark yellowish

bitter rhizome, 1 to 3 inches in length. It is not easily available in the plains. The chief active principle found in the bark is berberine which occurs in the root to the extent of 8.5 per cent. The drug is used in the indigenous medicine as a bitter tonic and resembles calumba in its properties. The fluid extract is the most suitable preparation. The roots of *Picrorhiza* and that of *Thalictrum foliolosum* are sold in the bazar as a substitute for the *C. teeta* root and are difficult to distinguish from it. Chatterjee and co-workers (1952) investigated the rhizomes of the plant and isolated berberine (9.0 per cent.), coptine (0.08 per cent.), palmatine (traces), coptisine (0.02 per cent.) and jatrorrhizine (0.01 per cent.). This is the first species of *Coptis* to yield jatrorrhizine.

3. COSCINIUM FENESTRATUM Colebr. (Menispermaceæ)

VERN.—Beng.—*Haldigach*; Dec.—*Jhadihaladi*, *Jharkihaldi*; Eng.—*Calumba wood*, *Ceylon calumba root*, *Columbo wood*, *Tree turmeric*; Mal.—*Haridram*, *Maramannal*; Mar.—*Venivel*; Sans.—*Daruharidra*, *Darvi*, *Pitadru*; Tam.—*Imalam*, *Kadari*, *Manjalkodi*, *Maramanjal*, *Pasamantram*, *Sanniyam*, *Seyebasam*, *Tiyaram*, *Udubadi*; Tel.—*Manupasupu*.

It is a climbing plant which grows plentifully in the forests of western India. The wood yields a dye resembling turmeric. The root is regarded as a bitter tonic and stomachic and is used in the same way as calumba. Berberine is the predominant alkaloid present.

CHEMISTRY OF BERBERINE.—Berberine, $C_{20}H_{19}NO_5$, is one of the chief constituents of *Berberis aristata* and *Hydrastis canadensis* (Golden seal). In the latter it occurs to the extent of nearly 2.5 per cent. along with two other alkaloids known as *hydrastine* and *canadine*. Berberine is an intensely yellow and bitter alkaloid. It is widely distributed in the root and bark and is the main source of the yellow colour of these plants. Berberine crystallises from water in long silky, reddish-yellow needles with $5\frac{1}{2}H_2O$; from chloroform it forms triclinic tables containing 1 $CHCl_3$; the acetone compound, $B.C_3H_6O$, forms reddish-yellow tablets. Berberine melts at $144^\circ C$. and when acidulated with sulphuric acid in a test tube and brought in contact with chlorine water it gives a blood-red ring at the junction. It precipitates with nearly all the alkaloid precipitants. Berberine base dissolves in 4.5 parts of water at $21^\circ C$. A number of salts, such as the carbonate, sulphate, hydrochloride, etc., have been prepared. They all have a yellow colour and are very sparingly soluble in water, except the acetate and the phosphate which have a solubility of 1 in 15 parts of water. The solubility of the sulphate is 1 in 150, but the acid sulphate is more soluble; the hydrochloride is soluble 1 in 400 parts of water. The solubility in water increases on warming the solution or on the addition of alcohol and benzol.

PHARMACOLOGICAL ACTION OF BERBERINE.—Berberine is not a very toxic alkaloid, its minimum lethal dose for rabbits being about 0.1 gm. per kilo. of body weight when administered subcutaneously. When administered intravenously to cats and dogs under urethane anaesthesia its toxicity is about 0.025 gm. per kilo. of body weight. Post-mortem examination of animals which are given lethal doses of the drug shows a marked congestion of the lungs and a wide dilatation of the auricles. Berberine is absorbed fairly rapidly when given by subcutaneous and intramuscular injections and does not set up any marked local reaction even when a 10 per cent. solution is injected. When the alkaloid is given by the mouth it can

be detected in the urine within a few hours showing that it is absorbed from the gastro-intestinal tract, and is excreted through the kidneys. A portion of it is, however, oxidised in the body.

Berberine has a stimulant action on the movements of the gastro-intestinal tract. The contractions of the stomach in an unanaesthetised cat are increased by subcutaneous injections of berberine. Intravenous injections of small doses of the alkaloid in anaesthetised animals, e.g. the cat and the dog, show a stimulant action on the movements of the small intestines. Perfusion experiments with pieces of different portions of the gut also show an increase in the tone of the muscle with such concentrations as 1 in 50,000 and less. The cardio-vascular system is depressed by intravenous administration of berberine salts. There is a sharp fall of blood pressure, the degree of fall and its duration depending upon the dose administered. This is due to dilatation of the blood vessels of the splanchnic area in particular. The force and amplitude of the isolated mammalian heart is decreased by such dilutions as 1 in 50,000. In myocardiographic experiments both the auricles and the ventricles are depressed and the heart shows a distinct dilatation. The respiratory system is markedly affected by the drug. Intravenous injections show an initial stimulation which might be due to the lowering of blood pressure or due to emboli formed in the capillaries of the lungs. The initial stimulation, however, soon gives way to depression especially when larger doses are given. The respiratory centre is depressed and death is generally due to failure of the respiration; the heart goes on beating long after the respiration stops. Gupta and Dikshit (1929) have shown that berberine is toxic to *Leishmania tropica* in concentrations as high as 1 in 80,000, while powerful protoplasmic poisons like quinine or emetine require about 80 times this concentration to produce the same effect. This specific toxic action of berberine has led to its use in 'oriental sore', due to an infection by *Leishmania tropica*.

THERAPEUTIC USES.—Berberine-containing plants have been used by both the Hindu and Mohammedan physicians as a stomachic, bitter and tonic in the same way as quassia and calumba. They have been used as an antiperiodic and alterative in remittent types of fevers. They have also been used in the treatment of leprosy, snake-bite, jaundice and vomiting of pregnancy. The fruits or berries of *B. asiatica* are given as a mild laxative to children. The stems are said to be diaphoretic and laxative and are recommended in rheumatism. The root bark is rich in bitter principles and is used as a tonic and antiperiodic. Instead of the root bark, the root itself is employed as an antiperiodic, diaphoretic and antipyretic and its action was believed to be as powerful as quinine. A decoction made from the root was said to bring down fever. The dried extract of the root known as 'rasaut' or 'ras' is used as a purgative for children, as a blood-purifier and as an external application in conjunctivitis in combination with opium. As a local application it is used for indolent ulcers. It has also been recommended for gastric and duodenal ulcers.

MALARIA.—Berberine and its compounds are reputed to have effective antiperiodic properties and have been used by Indian physicians in the treatment of

malaria for a long time. The author has used berberine sulphate in patients suffering from malaria at the Carmichael Hospital for Tropical Diseases, Calcutta. The drug was administered in 3 to 5 grain doses three times a day for three consecutive days, but there was no change in the paroxysms and microscopical examination showed no change in the number of malarial parasites. In a series of 9 cases which were tested, in no instance was there any change in the signs and symptoms of the patients. All infections whether those with *P. malariae*, *P. vivax* or *P. falciparum* remained unaffected by the alkaloid. Quinine administration in these patients had the desired therapeutic effect. It will be seen, therefore, that the belief that berberine is useful in malaria is not founded on facts. There is still another use of berberine in malaria not as a curative agent, but as a diagnostic measure. It is said to liberate the parasites into the circulation so that, whereas blood films taken before the administration of berberine are negative, those taken after it are positive. Sabastine (1926) used berberine as a provocative agent for the diagnosis of latent malaria. Percy Andre (1927) advocated the hydrochloride in cases of malarial splenomegaly. Chopra (1927) showed that injections of pentavalent compounds of antimony produce an increase in the volume of the spleen and the liver. Besides this, the rhythmic contractions of these organs are stimulated. The spleen is known to act as a filter to remove micro-organisms such as bacteria and protozoa from the blood stream and malarial parasites occur in large quantities in this organ. Berberine has been shown to increase the volume of the spleen and to increase its rhythmic contractions. It will, therefore, expel malarial parasites into circulation in the same way as Chopra and Das Gupta (1928) have shown that injections of antimony compounds expel the leishmania.

ORIENTAL SORE.—The most important use of berberine is, however, in the treatment of oriental sore. Jolly (1911) first tried 'rasaut', which contains large quantities of the crude alkaloid, in the treatment of this condition with varying results. Varma (1927) was the first to use berberine sulphate successfully in the treatment of oriental sore. Karamchandani in the same year tried different methods of treating the sore and reported that injections of berberine sulphate were most successful. Das Gupta and Dikshit (1929) tried berberine in patients suffering from sores as well as in experimentally-produced lesions in mice and concluded that the drug had a specific effect in curing these conditions. Lakshmidēvi in the same year reported several cases of oriental sore successfully treated with local injections of berberine. There is, therefore, no doubt about the effectiveness of this alkaloid in this form of cutaneous leishmaniasis. The following technique has been recommended:

1 to 2 c.c. of a 1 per cent. solution of the sulphate is infiltrated into the margins of the sore by means of a fine hypodermic syringe. Four or more punctures are made and care is taken to see that the infiltration is evenly spread. Injections are given once a week, and the sore is dressed with ordinary surgical dressings. As a rule not more than three injections are required to bring about a complete cure, but a large number of injections may have to be given until the desired results are obtained. It must be remembered, however, that if there are

multiple sores on the body, it is not advisable to infiltrate more than two sores a day and not more than four sores a week, especially if the sores are of a large size. The solutions of berberine sulphate are stable and can be preserved in sterile tubes with rubber caps, so that the requisite amount can be withdrawn with a syringe whenever required for administration. Messrs. May and Baker have recently put on the market ready-made solutions of berberine under the trade name 'orisol'.

4. TODDALIA ACULEATA Pers. (Rutaceæ)

VERN.—Hind.—*Jangli-kali-mirch*; Beng.—*Kada-todali*.

(See later)

Reference:—

(1) Jolly, G. G., 1911, *Ind. Med. Gaz.*, 46, 466; (2) Varma, R. L., 1927, *Ind. Med. Gaz.*, 62, 84; (3) Karamchandani, 1927, *Ind. Med. Gaz.*, 62, 558; (4) Chopra *et al*, 1929, *Ind. Jour. Med. Res.*, 16, 770; (5) Chopra, R. N., and Das Gupta, C. R., 1928, *Ind. Jour. Med. Res.*, 15, 565; (6) Das Gupta and Dikshit, 1929, *Ind. Med. Gaz.*, 64, 67; (7) Lakshmi Devi, A., 1929, *Ind. Med. Gaz.*, 64, 139; (8) Chopra, Dikshit and Chowhan, 1932, *Ind. Med. Gaz.*, 67, 194; (9) Ray and Roy, 1941, *Sci. and Cult.*, 613; (10) Chakravarti, K. K., 1950, *Jour. Sci. Industr. Res.*, 306; (11) Chatterjee, 1941, *Chem. Abst.*, 35, 8208; (12) Gupta and Kahali, 1944, *Ind. Jour. Med. Res.*, 53; (13) Guha, R., and Chatterjee, M. P., 1952, *J. Ind. Chem. Soc.*, 97; (14) Child and Nathanael, 1943, *Curr. Sci.*, 255; (15) Chatterjee, R., 1951, *J. Ind. Chem. Soc.*, 225; (16) Ahrendt, J., 1941, *Hot. Suppl.*, 68; (17) Chatterjee, R., Guha, M. P., and Dass Gupta, 1952, *J. Ind. Chem. Soc.*, 921.

BLEPHARIS EDULIS Pers. (Acanthaceæ)

VERN.—Arab.—*Kariz*, *Schokeddabb*; Beng.—*Shushani*; Bomb.—*Uttangan*; Guj.—*Khadakatira*, *Otigana*; Hind.—*Chaupatia*, *Guthava*, *Shiriyari*, *Uttanjan*; Mar.—*Karadu*; Pers.—*Anjara*; Punj.—*Uttangan*; Sans.—*Babhrū*, *Chachu*, *Grahaka*, *Kukkuta*, *Medhakrita*, *Sachidala*, *Shikhi*, *Shrivaraka*, *Suchipatra*, *Sutapatra*, *Svastika*, *Vitunna*; Urdu.—*Uttanjan*.

B. edulis Pers. is a shrub which belongs to the Acanthaceæ family. It grows in the Punjab and in Balauchistan. The leaves are commonly sold in the Indian bazars as a standard Indian medicine under the local name of Uttanjan and the Persian name Anjuri. The leaves are acrid with a distinct flavour and are considered by the Hindu Physicians to be cooling, astringent to the bowels, aphrodisiac, alterative, useful in tridosha fevers, urinary discharges, leucoderma and mental derangements. When applied locally they are said to have beneficial effects on wounds and ulcers. The seeds have the reputation of curing strangury. In the Mohemmadan medicine the root is considered diuretic; it is said to regulate menstruation and is beneficial in urinary discharges. The leaves are reputed to have tonic, aphrodisiac and purgative properties. They are said to stop nasal haemorrhage and are considered beneficial in asthma, cough and inflammation of the throat. In the treatment of ascites and liver and spleen

disorders the leaves are said to be useful. The seeds are tasteless and considered useful in urinary discharges. They are also beneficial in diseases of the blood, chest, lungs and liver. In Balauchistan, the seeds are applied locally in the treatment of conjunctivitis. Dymock reported that medicinally the seeds are considered diuretic, aphrodisiac, expectorant and deobstruent.

CHEMICAL COMPOSITION.—Dymock described the bitter principle of the seed as a white crystalline substance soluble in water, amyl and ethyl alcohols but insoluble in ether. Jagraj Behari Lal (1936) examined the seeds and isolated a bitter glycoside blepharin (yield 1.2 per cent.) and m.p. 222°C., with previous shrinking at 220°C.; it has the formula, $C_{10}H_{20}O_{11}$. He also isolated a tasteless nitrogenous compound having the formula, $C_4H_6O_3N_4$, melting with decomposition at 225-226°C. with previous darkening in colour at 218°C. It has been identified as dl-allantoin (Yield 2.1 per cent.). Later (1940) the same worker showed that air dried crystals of blepharin as obtained from rectified spirit and moist acetone have the composition, $C_{16}H_{20}O_{11} \cdot 1\frac{1}{2} H_2O$. It is a glycoside which is optically active.

No pharmacological studies of this glycoside have been carried out so far nor has its therapeutic efficacy been proved.

References:—

(1) Dymock, Warden and Hooper, 1893, *Pharmacographia Indica*, 41; (2) Jagraj Behari Lal, 1933, *J. Ind. Chem. Soc.*, 109; (3) Jagraj Behari Lal, 1940, *J. Ind. Chem. Soc.*, 259.

BOERHAAVIA DIFFUSA Linn. (Nyctaginaceæ)

Syn. Boerhaavia repens Linn.

PIGWEEED

VERN.—Arab.—*Handakuki*, *Sabaka*; Beng.—*Gadhapurna*, *Punarnaba*, *Sveta punarnaba*; Bomb.—*Ghetuli*, *Khapara*, *Punarnava*; Dec.—*Thikrikajhar*; Eng.—*Hogweed*, *Pigweed*; Guj.—*Dholi saturdi*, *Moto satodo*, *Vakha kaparo*; Hind.—*Sant*, *Thikri*; Mal.—*Thazhuthama*; Mar.—*Kharaparya*, *Pandharighentuti*, *Raktavasv*, *Vasv*; Pers.—*Devasapat*; Sans.—*Bhauma*, *Kathillaka*, *Krishnakhya*, *Krura*, *Lohita*, *Mandalpatrika*, *Nava*, *Navya*, *Nila*, *Nilapunarnava*, *Nilavarshabhu*, *Nilini*, *Pravrishayami*, *Pravrishenya*, *Punarbhava*, *Punarnava*, *Raktakanda*, *Raktapatrika*, *Raktapunarnava*, *Raktapushpa*, *Raktapushpika*, *Raktavarshabhu*, *Sarini*, *Shilatika*, *Shonapatra*, *Shophaghni*, *Shothaghni*, *Shyma*, *Vaishakhi*, *Varshabhava*, *Varshabhu*, *Varshaketu*, *Vikaswara*, *Vishaghni*, *Vishakarpara*; Sind.—*Nak bel*; Tam.—*Mukaratte*, *Mukurattai*; Tel.—*Atika mamidi*, *Punarnava*; Urdu.—*Bashkkhira*.

B. diffusa or *punarnava* has been in use in the indigenous medicine from time immemorial. The Ayurvedic authorities recognise two varieties of this plant, the one with white flowers called 'shweth-purna', and the other with red flowers, the 'rakt-purna'. In the Tibbi literature a third variety with blue flowers has also been described.

The plant grows all over India as a common creeping troublesome weed and is specially abundant during the rains. The roots are stout and fusiform and have a bitter and nauseous taste. From the root numerous stems, 2 to 3 ft. long, slender and covered with minute hairs, are given off. The stem is often viscid and glabrous; the leaves are thick, arranged unequally,

green and glabrous above and usually white underneath. The base of the leaf is rounded and subcordate, and the petioles are as long as the leaves. The flowers are small and sessile 4 to 10 together in small bracteolate umbels forming slender, long-stalked axillary and terminal petals. The fruit is oblong, dull-green or brownish and about the size of a caraway bean.

Dhanvantari described the white variety in 'Nighantu' as possessing laxative and diaphoretic properties. Its efficiency in oedema, anaemia, heart disease, cough and intestinal colic has also been mentioned by him. The red variety is bitter and its beneficial effects in oedema, haemorrhage, anaemia and biliousness have been extolled. In 'Rajnighantu', it is recommended in diseases of the nervous system, and in 'Bhavaprakash', in heart disease and piles. Charaka used it in the form of an ointment in leprosy and skin diseases, and as a decoction in stone in the kidney and in oedema. Local applications of the root paste have been recommended in oedematous swellings. Susruta mentions its use in snake-poisoning and rat-bite infection. Chakradatta used it in the treatment of chronic alcoholism and various other writers recommended it in phthisis, insomnia, rheumatism and diseases of the eye. The Tibbi physicians lay stress on its use in asthma, jaundice and ascites and mention its diuretic properties. They also use it as a vermifuge and febrifuge and in urethritis.

CHEMICAL COMPOSITION.—Ghoshal (1910) analysed the drug and found the following constituents. (a) A sulphate of a body alkaloidal in nature, (b) an oily amorphous mass of the nature of a fat, (c) sulphates and chlorides and traces of nitrates and chlorates from the ash. The amount of the alkaloidal matter is very small. The sulphate of the alkaloid is described as small needle-shaped crystals, brownish-white in appearance when in mass. Its taste is nearly bland or very faintly bitter and resembles that of impure quinine sulphate. The yield of the alkaloid as sulphate was 300 mg. from 20 oz. of the original plant (*i.e.*, 0.053 per cent.).

A detailed study of the chemical composition and pharmacological action of the active principles was undertaken by the author and his co-workers. As the green plant contained a very high percentage of water the air-dried plants had to be used for extraction.

The plant was found to contain unusually large quantities of potassium nitrate. As the presence of this salt may partly account for the diuretic action of the drug, the total content of potassium present in the plant was estimated. Taking the whole of potassium as potassium nitrate, its quantity in the powdered drug amounted to about 6.41 per cent. This is, however, unlikely and it is probable that other salts of potassium are present. Besides these salts, there is an alkaloid present in very small quantities, about 0.01 per cent. of the weight of dry plant. The alkaloid was isolated in just sufficient quantity for pharmacological experiments. It had a bitter taste and the hydrochloride was obtained in crystalline form. It has been named 'punarnavine'. The quantity, however, was not sufficient for further chemical work. Dutt and Co-workers (1934), found on systematic examination of the plant that it contains 0.05 per cent. of a crystalline acid to which the name boerhavic acid was given. They also found about 1 per cent. of potassium nitrate and about 1.2 per cent. of a brown mass consisting of tannins, phlobaphenes and reducing sugars (glucose mainly). No substance of an alkaloidal nature could be detected. Later they isolated 0.01 per cent. of a crystalline base and named it punarnavine. The presence of this alkaloid has been confirmed by Basu and Co-workers (1947) who have assigned the formula, $C_{17}H_{22}N_2O$, to it and characterised it through its pictrate, sulphate and platinum salt.

PHARMACOLOGICAL ACTION.—Ghoshal (1910) first took up the investigation of this drug. He used an aqueous extract of the whole drug in his experiments. This for obvious reasons is liable to cause error as the large quantity of nitrates, besides other salts of potassium and

various constituents, would mask the effect of the alkaloid and produce their specific effects on the tissues. His main conclusions were as follows: (1) The active principle is a diuretic, chiefly acting on the glomeruli of the kidneys through the heart, increasing the beat and strength and raising the peripheral blood pressure in consequence. On the cells of the tubules it exerts little or no action, and if any, it is initial and comparative. (2) On the respiration it has little or no action; any action is probably due to the fatty principle found in the weed. (3) On the liver the action is principally secondary and in combination with other drugs. (4) On the other organs the drug has practically no effects.

In the experimental work done by the author and his co-workers, the hydrochloride of the alkaloid was used. It has little or no irritant action on the intact skin and mucous membrane. Subcutaneous injection does not set up any marked local reaction; it has a somewhat depressing action on the tone and peristaltic movements of isolated pieces of the intestine from the rabbit. Intravenous injection of the alkaloid stimulates the respiratory movements in experimental animals but there is no relaxation of bronchial muscles such as occurs with adrenaline. The blood pressure shows a distinct and persistent rise which is probably due to the direct action of the drug on the heart muscle. The diuretic effects were investigated in the cat and the dog; intravenous injections in such animals, where the flow of urine is being recorded by a cannula into the ureter, showed a marked increase in the flow of urine. That the diuresis was not entirely due to the rise of blood pressure was shown by giving 1/20 c.c. of 1 in 1,000 adrenaline solution intravenously; it was observed that, although there was a much bigger rise of blood pressure, the diuresis was comparatively much less marked. It may be concluded, therefore, that the effect of the alkaloid is probably chiefly on the renal epithelium. That the alkaloid is not very toxic was shown by the fact that large doses given to animals produced no untoward effects.

THERAPEUTIC USES.—The fact that most of the previous observers laid great stress on the diuretic properties of *B. diffusa*, and that these results were confirmed by animal experiments, led the author to test the drug in patients suffering from oedema and dropsy due to various causes. As a sufficient quantity of the alkaloid could not be obtained for clinical trials we had to use the liquid extract prepared from the plant. The extracts were made both from the dry and fresh plant (white variety) and were found to be equally efficacious. One c.c. of the extract was equivalent to 1 gm. of the dried plant and this was given in doses ranging from 1 to 4 dr. The amount of the alkaloid in such doses worked out to be 0.35 to 1.40 mg. or roughly 1/40 to 1/160 gr. The total amount of potassium base (not salts) in similar doses would be 1.5 to 6.0 gr. and of this potassium nitrate would be $\frac{1}{2}$ to 2 gr. The drug was carefully tried in a series of 34 cases. This series, though not very large, gave convincing results about the therapeutic effects produced by the drug. Excepting an occasional purgative no other drugs were given whilst the extract was being administered. In cases of ascites due to early liver and peritoneal conditions the drug appears to be very beneficial. It produced a very marked and persistent diuresis and in some cases the ascites entirely disappeared. The diuretic effect, though not so marked, was produced even when the abdominal fluid was not removed by preliminary tapping and the kidneys were working under a disadvantage. If the tension inside the abdomen was high and the urine

was scanty and albuminous the drug failed to produce an effect unless the ascites was previously relieved.

A number of the patients on whom the drug was tried were either complicated with kala-azar or the dropsical condition was possibly due to kala-azar. In them the improvement was not marked until the treatment with antimony injections was given simultaneously. It may be argued that the beneficial results in these cases were entirely due to the effect of antimony injections but it was found that such marked diuresis is as a rule not caused by antimony alone. In some of the cases cited below the amount of urine was two to three times the normal quantity secreted in healthy individuals, and this increase was maintained even when the ascites and oedema had disappeared and after the antimony injections were stopped. As a matter of fact, ascites in cases of kala-azar is not a common condition and when it appears is usually terminal. The drug acts best when the dropsical condition is associated with healthy kidneys as in kala-azar or ascites caused by dysenteric conditions. Diuresis though it does occur in patients with copious albumin in their urine, is often not so marked. As regards dropsy due to cardiac conditions, its effect does not appear to be very marked. In such cases digitalis or the ephedrine group of drugs are much more efficacious. In ascites with advanced structural changes in the liver, kidneys and peritoneum, only temporary benefit can be expected, but even in such cases the condition is greatly improved. In a certain number of cases the quantity of urine decreased somewhat after prolonged administration of the drug for a period of 4 to 6 weeks and it was thought that perhaps this was due to the toxic effect of the drug. To test this point, 2 to 3 dr. of the extract were given three times a day for over 2 months to several cases. It was observed that the quantity of urine passed did not materially alter and in some cases the diuretic effects were maintained even after the drug was discontinued. In one case, the diuresis was maintained for nearly six weeks after the administration was stopped.

SUMMARY.—The active principle of *B. diffusa* is a body of alkaloid nature called 'punarnavine'. There are also large quantities of potassium nitrate and other potassium salts present in this plant. Intravenous injections of the alkaloid in experimental animals produce a distinct and persistent rise of blood pressure and a marked diuresis. The diuresis is mainly due to the action of the alkaloid on the renal epithelium, although the rise in blood pressure may contribute towards it. Clinically, 1 to 4 dr. of the liquid extract made from either the dry or the fresh plant, produce diuresis in cases of oedema and ascites, especially those due to early liver, peritoneal and kidney conditions. When the liquid extract is used the presence of a large amount of potassium salts no doubt reinforces the action of the alkaloid. The drug appears to exert a much more powerful effect on certain types of ascites, i.e., those due to early cirrhosis of the liver and chronic peritonitis (Hale White) than some of the other diuretics known.

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(1) Ghoshal, L. M., 1910, *Food and Drugs*, October, 80; (2) Chopra, R. N., Ghosh, S., Ghosh, B. N. and De, P., 1923, *Ind. Med. Gaz.*, 58, 203; (3) Dutt and Aggarwal, 1934, *Proc. Ind. Acad. Sci.*, 73; (4) Basu, Lal and Sharma, 1947, *Quart. J. Pharmacol.*, 38.

BRAGANTIA WALLICHII R. Br. (Aristolochiaceæ)Syn. *Apama siliquosa* Lam.VERN.—Mal.—*Alpam*; Mar.—*Chakrani*; Sans.—*Chakrani*; Tel.—*Tellayishwari*; Kan.—*Niruvate*.

This is a small bush with decumbent branches. It grows in the southern half of Bombay State near the sea coast and in Madras and Ceylon. The whole plant mixed with oil and reduced to an ointment is said to be effective in chronic sores and ulcers. The root in the form of paste is given in the treatment of cholera and diarrhoea. According to Mhaskar and Caius, the root and leaves are useless as an external application in the treatment of snake bite. The mature rhizomes are used by the Ayurvedic physicians of Konkan and Mallanad districts of Mysore in the treatment of dysentery. Roots are ground into a paste with lemon juice (4 g. in 14 c.c.) and administered orally every 15 minutes till acute symptoms disappear. It is also claimed that the paste is beneficial in the treatment of carbuncles and the root given internally is beneficial in cholera.

CHEMICAL COMPOSITION.—Shanker Rao and Co-worker (1938) examined the root and found a fatty oil containing palmitic, lignoceric, oleic and linolic acids. Beside this a yellow substance which separated from the different extracts was found to be identical with isoaristolochic acid isolated from *Aristolochia indica*. The roots answered qualitative tests for alkaloids, but no pure base has been isolated.

No proper clinical trials of its effectiveness in dysentery and cholera have been carried out so far.

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- (2) Chakravarty, D., 1944, *Ind Jour. Pharm.*, 96.

BUTEA MONOSPERMA (Lam.) Kuntze (Leguminosæ)Syn. *Butea frondosa* Koen. ex-Roxb.

BENGAL KINO

VERN.—Beng.—*Palas*; Bomb.—*Palas-ka-jhar*, *Tesu-ka-jhar*; Hind.—*Dhak*, *Palas*, *Tesu-ka-per*, *Kakria*, *Chichra*; Mar.—*Paras*, *Phalasa-cha-jhada*; Tam.—*Porasan*, *Murukkan*, *Puraishu*, *Palasham*; Sans.—*Kinsuka*, *Palasa*; Pers.—*Darakhte pallah*, *Palah*.

This is a moderate sized deciduous tree found throughout India and Burma extending in the north-west Himalayas as far as the Jhelum. It is one of the most beautiful trees of the plains and lower hills of India and nearly every part of this tree has been put to some useful purpose. It yields naturally or from artificial scars on the bark, a gum which is sold as 'Bengal kino'. The gum was mentioned by Chakradatta as an astringent and in combination with rock salt was used as an external application. It is largely used as an astringent and as a substitute for the 'kino' in India and to a limited extent in Europe also. Waring in his 'Bazar Medicines' remarks that it is an excellent astringent, similar to catechu,

but mild in operation and hence is better adapted for children and delicate females. The dose of the powdered gum is 10 to 30 grains with a few grains of cinnamon. The flowers and leaves are also used. They are said to possess astringent, diuretic and aphrodisiac properties. Made into the form of a poultice, they are used as antiphlogistics in swellings and boils. The fresh juice is given internally in phthisis and also as an external application, to ulcers and congested and septic throats.

The seeds have been administered internally, either in the form of powder or made into a paste with honey, as an anthelmintic from very ancient times. In the 'Bhavaprakasa', the use of the seeds of 'palasa' as an aperient and anthelmintic is mentioned. Considerable difference of opinion exists as regards the anthelmintic action of the seeds. Some medical men consider that they can be advantageously substituted for santonin against roundworms while others do not find them to be so effective.

CHEMICAL COMPOSITION.—Chemical analysis of the seeds showed 18 per cent. of a fixed oil called moodooga oil or kino-tree oil, small quantities of a resin and large quantities of a water-soluble albuminoid. The composition of this oil has been worked out by Tummin Katti and Manjunath (1929). A number of fatty acids have been isolated from the oil. The physical and chemical constants of the oil are: Sp. gravity 0.89 at 25°; refractive index 1.4650 at 25°; saponification value 174; iodine value 67.2; unsaponifiable matter 2.3 per cent. Fresh seeds are reported to contain proteolytic and lypolytic enzymes. The former is a mixture of plant proteinase and polypeptidase, and behaves like 'yeast trypsin'. The flowers yield a brilliant but very fugitive yellow colouring matter. This is contained in the sap and may be obtained in the form of a decoction or infusion from dried flowers. The addition of alum, lime or an alkali deepens the colour to orange and also makes it less fugitive. The sap contains the chalcone, butain, $C_{15}H_{12}O_5$, (0.3 per cent.) occurring in orange yellow needles, m.p. 213-215°C., and small quantities of butin, the colourless isomeric flavanone, and its glycoside butrine.

The oil is practically inert and does not possess any anthelmintic activity. Active principle of the nature of alkaloid, neutral principle or glycoside could not be isolated from the seeds.

THERAPEUTIC USES.—Fresh seeds ground in the form of a powder were tried in a large number of patients suffering from ascaris infection. The results obtained were not at all uniform and it was difficult to form an opinion about the efficacy of the drug. In one series of over 30 cases, the drug proved to be very efficacious and was almost at par with santonin. In another similar series the results were disappointing. These seeds are very unpleasant to take and often produce retching, pain in the abdomen and occasionally vomiting and giddiness. The oil, the powdered seeds and the alcoholic extract made from seeds were separately tested but were quite ineffective against hookworms and roundworms. The old worm-eaten seeds, as are frequently met with in the market, show little activity but freshly powdered new seeds give fairly good results against ascaris.

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Baltimore; (4) Tummin Katti and Manjunath, 1929, *Jour. Ind. Chem. Soc.*, 6, 839; (5) Chatterjee, Ghosh and Chopra, 1938, *Jour. Ind. Chem. Soc.*, 101, 107; (6) Hummel and Perkin, 1944, *J. C. S.*, 1463; (7) Lal and Dutt, 1935, *Jour. Ind. Chem. Soc.*, 262; (8) Murti and Seshadri, 1940, *Proc. Ind. Acad. Sci.*, 477.

BUTEA SUPERBA Roxb. (Leguminosæ)

VERN.—Beng.—*Latapalash*; Bomb.—*Palasavela*, *Palasi*; Guj.—*Velkhakar*; Mar.—*Beltivas*, *Palasavela*, *Yelparas*; Sans.—*Latapalasha*; Tel.—*Modugaige*, *Tigemoduga*, *Tivvamoduga*.

This is a gigantic climber which grows in the forests of Oudh and Bundhelkhand, Chota Nagpur, central and southern India. The plant is used as a household remedy in eruptions of children occurring in hot weather, the juice extracted from leaves being given with curd and yellow-zedoary. In Combodia a decoction of the stem and leaves is considered emollient and used as a local application for piles. Water in which the plant has been macerated is much recommended as sedative. The flowers and bark have been claimed to be useful in scorpion-sting and snake-bite, but Caius and Mhaskar have observed that no part of the plant is an antidote to snake venom or to scorpion venom.

CHEMICAL COMPOSITION.—Khasem (1938) investigated the roots and isolated two glycosides but did not study their properties. Vatna (1940) obtained from the storage root of the plant an estrogenic substance and a poisonous substance which is readily soluble in water but sparingly in 95 per cent. alcohol. Seshadri and Rao (1949) examined the flowers of the plant and obtained the same crystalline components as obtained from *B. frondosa*, i.e. butrin, butein and butin. The flowers have a marked orange red colour but this seems to be due to the presence of carotenoides.

PHARMACOLOGICAL ACTION.—In concentration of 100 mg. per litre (a dilution of 1 in 10,000), butein is toxic to fish which turn upside down in the course of two hours. Fifty per cent. of these do not recover but die even after their removal to fresh water. On the other hand butin is considerably less toxic since, even in concentrations of 200 mg. per litre, it exhibits no toxic effect on the fish even after contact for 24 hours.

An aqueous extract equivalent to 0.06 oz. of the dried powder of the Butea root produces symptoms of poisoning in adult mice while doses greater than this are fatal. Very large doses of an alcoholic extract evaporated to dryness and suspended in olive oil produce only mild symptoms of poisoning. However, an injection of this extract equivalent to 0.002 gm. of the dried powder is the minimum dose which will cause oestrus in spayed female mice. The aqueous extract from 0.015 gm. of the powder is the minimum amount which will cause oestrus, and at this dilution the poison dissolved produces no visible effect on the mice. This plant apparently has marked oestrogenic properties and deserves further study with regard to the pharmacological action of the active principles isolated. It is possible that here we may find a source of estrogenic compounds for therapeutic purposes.

References:—

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CÆSALPINIA BONDUCELLA Flem. (Leguminosæ)

BONDUC NUT; FEVER NUT; PHYSIC NUT

VERN.—Sans.—*Kuberakshi*, *Putikaranja*; Hind.—*Katkaranj*; Beng.—*Nata karanja*; Bom.—*Sakur-ghota*; Tam.—*Kazhar-shikkay*; Pers.—*Khayahe-i-iblis* (Devil's testicle).

C. bonducella grows near the sea coast in all hot countries, the extensive distribution being due probably to the transport of the seeds by oceanic currents. It is a climbing prickly shrub common all over Bengal, Bombay and practically the whole of southern India. The plant has long been known to the Hindu and Mohammedan physicians for its medicinal properties. The seeds are nearly globular in shape varying in size from $\frac{1}{2}$ inch in diameter; they are very hard, of a dull grey colour and smooth in appearance. The shell is thick and brittle and contains a yellowish-white kernel which is very bitter to the taste. The root, bark, leaves and the seeds are used in medicine. Ruphius called the seeds *Frutex globulorum* and says that they have anthelmintic properties and the leaves, roots and seeds are emmenagogue and febrifuge.

The seeds are considered in India and Persia to be 'very hot and dry', and useful for dispersing swellings, restraining haemorrhage and keeping off infectious diseases. The seeds roasted and powdered are administered for hydrocele internally and at the same time applied externally; they are also given internally in leprosy. The powdered seeds mixed with black pepper are febrifuge and anti-periodic and are used in chronic fevers. The fixed oil expressed from the seeds is emollient and is used as an embrocation to remove freckles from the face, as a cosmetic and also to stop discharges from the ear. A decoction of the roasted seeds is used against consumption and asthma. The seeds consist of 58 per cent. of hard outer shell and 42 per cent. of kernel. In 1868 the seeds were made official in the Pharmacopoeia of India as a tonic and antipyretic and were favourably reported on by several medical officers.

CHEMICAL COMPOSITION.—Heckel and Schlagdenhauffen (1886) found that the cotyledons of the seeds contain, besides starchy matter 25.13 per cent. of an oil, 1.925 per cent. of a bitter principle, 6.83 per cent. of sugar and 3.791 per cent. of salts. A non-alkaloidal bitter principle was obtained from the kernels in the form of a white powder (bonducin) to which they attributed the physiological properties of the seeds. It was found to be insoluble in water but soluble in oils. Bacon (1906) was able to isolate from the kernels the bitter principle 'bonducin' which he found to be a mixture of complex resinous bodies. He could not obtain any alkaloid or glycoside from the alcoholic extract of the kernels. Bhaduri (1912) stated that an alkaloid was present in the seeds and suggested the name 'natin' for it. It is doubtful whether 'natin' of Bhaduri is a glycoside or an alkaloid as details are not available. Godbole, Paranjpe and Shrikhande (1929) found that the bitter principle of the kernels extracted with alcohol, contained all the sulphur of bonducella nut and reduced Fehling's solution after hydrolysis. They concluded, therefore, that the bitter principle was a glycoside. Tummin

Katti (1930) found a bitter resinous acid in the petroleum ether extract and identified it as 'bonducin'.

In view of the divergent results of chemical analysis, the seeds were re-examined at the Calcutta School of Tropical Medicine to see what active principles could be detected in them. They yielded to petroleum ether 13.52 per cent., sulphuric ether 1.84 per cent., chloroform 0.42 per cent. and absolute alcohol 18.55 per cent. of the dried extract. Each of the above fractions was then chemically examined. The presence of an alkaloid as noted by the previous investigator could not be confirmed, but a non-glycosidic bitter principle insoluble in water was undoubtedly present; it is, however, pharmacologically inactive. The seeds contain a fairly good percentage of pale yellow thick oil having a disagreeable odour. It has an iodine value of 96.1 and saponification value of 292.8. According to some workers the quantity of the oil varies between 20 to 25 per cent., whereas in the specimens examined by the author it never exceeded 14 per cent. Ghatak (1934) investigated the kernels of the seeds and showed the presence of a non-crystalline bitter glycoside bonducin, a neutral saponin, starch, sucrose, an enzyme, a yellow oil and an amorphous tasteless powder. He could not detect any alkaloidal or sulphur containing glycoside.

PHARMACOLOGICAL ACTION.—The non-glycosidic bitter principle was passed through the usual pharmacological tests but it was found to be inactive. Mukerjee and co-workers (1943) studied the antimalarial properties of the drug. An alcoholic extract of *C. bonducella* nuts (fat free powder prepared from the kernels) when fed in doses upto 4,000 mg. per gm. body weight failed to arrest the normal multiplication of *P. gallinaceum* in domestic fowls, moreover the parasite showed no morphological changes. It would thus appear that the drug has no action whatsoever in malaria.

THERAPEUTIC USES.—The so-called 'bonduc nuts' or 'fever nuts' have enjoyed a reputation as anti-periodic for such a long time that clinical trials were carried out under the auspices of the Indigenous Drugs Committee. Though their findings are not very definite, they recommended the drug very favourably as a powerful tonic and a valuable febrifuge. As the seeds do not show any marked therapeutic properties and the re-investigation of their chemical composition does not reveal the presence of any active principle with marked pharmacological action, further clinical trials were considered unnecessary.

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CALOTROPIS GIGANTEA (Linn.) R. Br. (Asclepiadaceæ)

GIGANTIC SWALLOW-WORT

VERN.—Arab.—*Ashur, Oschor, Oshmor, Oshar*; Beng.—*Akanda, Gurtakand, Swetakond*; Guj.—*Akado, Akdamujhada, Dhola akdo, Nohanoakdo, Ratoakdo*; Hind.—*Ag, Ak, Akan, Akond, Ark, Lalak, Lal madar, Madar, Mudhar, Safedak*; Mal.—*Bukam, Dinesam, Vellerikku, Yerriku*; Mar.—*Akanda, Akdachajhada, Lalakara, Lal madar, Lal rui, Muda*; Nepal.—

Auk; Pers.—*Khark*; Sans.—*Aditya*, *Aharbandhava*, *Aharmani*, *Aharpati*, *Arka*, *Asphotaka*, *Bhaskara*, *Divakar*, *Ganarupa*, *Kirtanuphala*, *Kshiradala*, *Kshiraparni*, *Mandara*, *Prabhakara*, *Sadapushpa*, *Sadasuma*, *Savita*, *Shita-pushpaka*, *Shukaphala*, *Suryavgha*, *Tulaphala*, *Vibhakara*, *Vibhavasva*, *Vikartana*, *Vikorana*, *Vivasvana*; Tam.—*Arkkam*, *Arukkam*, *Arulagam*, *Aruchunam*, *Erukku*, *Mirugusayidagam*, *Suriyam*, *Suvedagusuman*, *Udumbaram*, *Vellerukku*, *Mandarasu*; Tel.—*Arkamu*, *Nalljilledu*, *Rachajilledu*, *Uste*; Urdu.—*Ak*.

The medicinal properties of *C. gigantea* were known in this country from the earliest time. It is mentioned by the earliest Hindu writers and the ancient name of the plant which occurs in the Vedic literature was *Arka* (wedge) alluding to the form of leaves which was used in the sacrificial rites. The vernacular name 'madār' is derived from 'mandāra', one of the sanskrit names of the plant. Two varieties of the plant are described by the sanskrit writers, viz. the white flowered or 'alarka' (probably *C. procera*) and the purple flowered or 'arka' (*C. gigantea*). The ancient Arabs also held superstitious notions about calotropis, probably connected with sun worship.

C. gigantea is an erect perennial shrub, growing chiefly in waste lands. It ascends to an altitude of 3,000 ft. on the Himalayas, and extends from the Punjab to south India, Assam, Ceylon and Singapur and is distributed to the Malaya Islands and south China. It thrives in soil where nothing else will grow and requires neither cultivation nor water; it is thus admirably adapted for bringing waste lands under tillage and for protecting reclaimed deserts from drifting sands. These reasons alone should suffice to encourage the cultivation of the plants apart from its value as a medicinal plant or fibre producer. The root barks of *C. gigantea* and *C. procera* are similar in appearance and occur in short pieces $\frac{1}{4}$ to $\frac{1}{2}$ inch thick. The taste is mucilaginous and bitter and the odour is peculiar.

A kind of gutta-percha may be prepared from the milky sap. But calotropis gutta-percha cannot be regarded of any commercial importance as being a good conductor of electricity it is unsuitable for cable purposes. The milky juice is also used for tanning and dyeing. It imparts a yellow colour to the skin and destroys the offensive smell of the fresh leather. Dymock adds that the tanners also use the juice to remove the hairs from the skin.

An intoxicating liquor is said to be prepared from the juice of the plant. The sacred 'soma' juice of the ancient Sanskrit writers has by many botanists been associated with a species of plant, belonging to a tribe not very far removed from calotropis. The plant is said by the Arabs and Persians to yield a sugar or manna, but no definite information regarding this property is available. The manna said to be obtained from the plant is known in the bazar as 'sakkur-el-ushai' and is said to be produced through the parasitic action of *Larimus ursus*.

The plant yields two distinct fibres: (1) silk-cotton from the seeds known commercially as 'madar floss' and (2) rich white bastfibres from the bark. Several authors refer to the possibility of using this silk-cotton as paper pulp, but unless cultivated, its collection would be far too expensive to admit of this. The fibre is certainly fine, strong, white and silky, and could doubtless be put on a commercial footing, but the obstacles to its profitable utilization on a large scale outweigh its natural good qualities. The chief obstacles are (1) the very small proportion of fibre to the weight of the stem, being only 1.56 per cent. and (2) the shortness of fibres, extending as they do from joint to joint. These two obstacles are sufficient to justify the withdrawal of the madar from the list of hopeful fibre-bearing plants in India.

CHEMICAL COMPOSITION.—The latex which is present in all parts of the plant, contains water and water soluble matter 86.0-95.5 per cent. and caoutchouc 0.6-1.0 per cent. The coagulum consists of caoutchouc 5.1-18.6 per cent., resins 73.6-87.8 and insoluble matter 4.5-13.8 per cent. The latex contains two isomeric resinols, α -calotropeol, $C_{30}H_{50}O$ (m.p. 204-5°C.), and β -calotropeol (m.p. 216-17°C.) mainly in ester combination with acetic and isocaleric acids, and β -amyrin. It also yields a nitrogen and sulphur containing compound named gigantol, (m.p. 243° decomp.) which is similar to but not identical with uscharin obtained from the combined latex of African *C. gigantea* and *C. procera*. This compound is depressant to heart and acts as a poison to fish. Small quantities of unidentified tetracyclic compounds and calcium oxalate are also present. The latex also contains traces of glutathione and proteoclastic enzyme similar to papain. The stem bark contains α - and β -calotropeols, β -amyrin, giganteol, a colourless wax, small amounts of tetracyclic terpene and traces of sterols. The flowers contain esters of β -calotropeols, β -amyrin, volatile and long chain fatty acids, and esters of waxy acids and alcohols. Analysis of the seeds gave, moisture 7.4 per cent., protein 27 per cent., ether extract 26.8, crude fibre and nitrogen extract 32.4 and ash 6.65 per cent. The oil extracted from the seeds is an olive green liquid the acid fraction of which contains palmitic acid 15 per cent. oleic acid 52 per cent., linoleic acid 32, and linolenic acid 0.9 per cent. The unsaponifiable fraction (31 per cent.) of the seed wax gave; phytosterol, m.p. 136°C., stigmasterol, m.p. 170°C., melissyl alcohol and a hydrocarbon laurane $C_{20}H_{42}$ (0.6 per cent.) (Wehmer, II, 1001). The latex has not found any industrial application. It is used to a limited extent in the tanning industry for deodorising, removing hair and imparting a yellow colour to hides. It is said to be adulterant of Persian opium. The root bark contains β -amyrin, 2 isomeric crystalline alcohols, giganteol (m.p. 223-24°C.) and iso-giganteol (m.p. 117-78°C.) which are probably dihydric giving colour reactions similar to those of calotropeols. A colourless substance (m.p. 162°C.) which is probably a tetracyclic triterpene alcohol has been obtained from the unsaponifiable fraction of the fatty matter. The ash of the *C. gigantea* (12 per cent.) is rich in potash (K_2O 20.8 per cent.). The wood yields a light charcoal which is used in gun powder and fire works.

Calotropis juice is caustic when applied to unbroken skin or mucous membranes. An extract of it caused slowing of the heart and acute gastro-enteritis when injected into the lymph sac of frogs; it was highly toxic to dogs and donkeys when given by the mouth or subcutaneously. An alcoholic extract of the bark, given by mouth to dogs, caused persistent contraction of the intestines; intravenously it increased force of the heart. It causes contraction of the isolated rabbit uterus.

THERAPEUTIC USES.—The Hindu physicians consider the root bark as a valuable remedy in skin diseases, enlargement of abdominal viscera, intestinal worms, cough, ascites, etc. The milky juice is regarded as a drastic purgative and is generally used as such in combination with the juice of *Euphorbia neriifolia*. The flowers are considered to be digestive, stomachic, tonic and useful in cough, asthma and catarrh. The root bark reduced to a paste with rice-vinegar is applied to elephantiasis of the legs and scrotum. For medicinal purposes the root bark of *C. gigantea* should be collected from as old a plant as possible and in hot, dry weather. An ordinary medicinal dose of the powdered bark as an alterative is 3 to 10 gr. thrice daily. In doses of 30 to 60 gr. the root bark acts as an emetic and has been used as a substitute for ipecacuanha. All parts of the plant are considered to have valuable alterative properties when taken in small doses. According to Chevers and others, forcing madar juice down the throat is a common method of infanticide employed by castes among which female infanticide prevails. Madar juice is also given internally or applied locally to procure abortion. Like all other

irritant vegetable juices it is used locally; usually a stick smeared with the juice is pushed up into the *os uteri* and left there until uterine contractions are induced. In some parts of India, it is also used as a cattle poison.

Recent investigations do not bear out the claims made on behalf of *C. gigantea*. Apart from its local irritant action, it has no demonstrable therapeutic properties.

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CALYOPTERIS FLORIBUNDA Lam. (Combretaceæ)

It is a large diffused or scandent shrub with yellowish green flowers which grows in central and southern India. It is generally met with in the plains going upto an altitude of 2,500 ft. above sea level. The leaves are considered laxative, anthelmintic and the juice is given in puerperal fevers. The leaves are bitter, astringent and are chewed, the juice being swallowed as a remedy for colic. When ground and administered with butter, the leaves are reported to cure dysentery and malarial fevers. They are also used as external application in the treatment of ulcers. The root ground to paste with that of *Croton oblongifolium* is recommended against snake-bite but Caius and Mhaskar found that it is useless. The stems store a large quantity of water and the stem juice is taken by the Forest Tribes in India for allaying thirst when water is scarce. The juice is not injurious to health.

CHEMICAL COMPOSITION.—The juice of the plant was examined by Ryan (1904) who found that it contains total solids 0.07 per cent., organic and volatile matter 0.05 per cent. and mineral matter 0.02 per cent. The organic matter consists of tannin, traces of albuminoids and gummy matter. Starch and sugar are absent, acetic and other free acids are present in small quantities. The mineral matter consists chiefly of chlorides, sulphates, traces of nitrates, lime and ferric oxide. The leaves contain a yellow crystalline flavone calycopterin, $C_{19}H_{18}O_8$, the presence of which in the leaves might account for the anthelmintic property attributed to them. The mature leaves are known to be better source of calycopterin than tender one.

ACTION AND THERAPEUTIC USES.—There is considerable difference of opinion concerning value of this drug as an anthelmintic. It is toxic to fish and earthworms and it has been observed by Khorana (1948) that it is more toxic to earthworms than santonine or oil chenopodium but less toxic than carbon tetrachloride or thymol. Calycopterin content of the leaves appears to be 0.3 per cent., hence it would follow that a dose comparable with other anthelmintics would be from 50 to 100 gm. of the leaves. Nadkarni has suggested that the leaves should be ground into paste and made into 5 gr. pills and administered for expulsion of round worms. It is evident that to administer an effective dose

either a concentrated extract of the leaves or preferably pure calycopterin should be used. No proper clinical trials have been carried out but in view of the small quantities of flavone contained, it is not likely to be of any great use in therapeutics as an anthelmintic.

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CARICA PAPAYA Linn. (Caricaceæ)

THE PAPAW OR PAPAYA TREE

VERN.—Arab.—*Aanabahehindi*; Beng.—*Papeya*, *Pappaiya*, *Pepiya*; Bomb.—*Papai*; Dec.—*Popai*; Eng.—*Melon tree*, *Papaw*, *Papaya*, *Papeta*, *Pawpaw*, *Tree melon*; Hind.—*Andakharbujā*, *Papaya*, *Papita*, *Pepiya*, *Popaiya*; Mal.—*Kapalam*, *Karmmosu*, *Pappayam*; Mar.—*Papaya*; Pers.—*Ambahindi*; Punj.—*Arandkharbuzā*, *Kharbuzā*; Sans.—*Chirbhita*, *Erandachirbhita*, *Nalikadala*; Sind.—*Chibhado*, *Katha*; Tel.—*Boppayi*, *Madananaba*, *Madhurnakamu*; Urdu.—*Erand kharbujah*.

C. papaya is a sub-herbaceous almost branchless tree found throughout India. It is said to have come from Mexico and Brazil but it is now grown as a fruit tree in gardens throughout India and its ripe fruit is greatly appreciated. The juice of the fruit is regarded as a medicine in all countries where the tree is found. The milky juice of the unripe fruit is said to possess powerful anthelmintic properties especially against roundworms. Anthelmintic property has also been claimed for its seeds but their efficacy in this respect appears to be doubtful. A belief in their powerful emmenagogue properties prevails amongst all classes of women in south India but here also evidence is wanting in support. The milky juice is applied locally to the *os uteri* for inducing abortion. The most important medicinal property of the fruit is found in 'papain', a digestive enzyme, which is present in the milky juice and also occurs to a certain extent in the green fruit.

In the early stages, the fruit secretes a white milky viscid juice of the consistency of cream which has the extraordinary property of hastening the digestion of muscular fibre exposed to its influence. This active principle, which resembles pepsin in its physiological properties, may be obtained by adding alcohol to the juice of the unripe fruit and powdering the residue after drying. This substance is called 'papain' and is superior to ordinary animal pepsin in having the peculiar additional advantage of requiring neither the aid of an acid nor an alkali to convert the contents of the stomach into peptones. The digestive action of this plant on meat was probably known in the West at a very early date and appears to have been communicated to India upon the introduction of the tree by the Portuguese. The author of the '*Makhzan-el-adwiya*' (1770) accurately describes the tree and mentions the use of the juice mixed with fresh ginger, for making meat tender. Although this property of the fruit and leaves seems to have been known through-

out India for a long time, no attempt appears to have been made to manufacture 'papain' (vegetable pepsin) on a large scale. Of recent years, a small trade has sprung up in some countries in the preparation of 'papain' from this fruit.

CHEMICAL COMPOSITION.—The milky juice of papaw contains a ferment which has an extraordinary energetic action upon nitrogenous substances and like pepsin curdles milk. This juice differs from pepsin in being active without the addition of free acid; moreover the ferment acts at a higher temperature than animal pepsin.

Analysis of the fruit gave, moisture 89.6 per cent., proteins 0.5, carbohydrate 9.5, ether extract 0.1, mineral matter 0.4, calcium 0.01, phosphorous 0.01 per cent. and iron 0.4 mg./100 gm. The fresh fruit pulp contains sucrose, invert sugar, a resinous substance, papain, malic acid and salts of tartaric and citric acids 1.2 per cent. Both ripe and unripe papaya fruit is a rich source of pectins. The presence of the following carotenoid pigments has been reported in the fruit: kryptoxanthin, violaxanthin, zeaxanthin, β -carotene, neo- β -carotene B and neo- β -carotene U. The fruit is a rich source of vitamins. It contains carotene calculated as vitamin A 2,000-3,000 I.U., thiamine 15-63 mcg., riboflavine 23-83 mcg., niacin 0.15-0.76 mg. and ascorbic acid 33-136 mg. per 100 gm. of the fruit pulp. The amount of carotene in the fruit is much smaller than is indicated by biological assay. It is suggested that a few of the xanthophylls present in the fruit possess vitamin A activity. The seeds of *C. papaya* are black in colour and possess a cress-like odour. They contain protein 24.3 per cent, carbohydrates 15.5, fatty oil 25.3, crude fibre 17.0, ash 8.8, volatile oil 0.09 per cent. A glycoside, caricin, resembling sinigrin and the enzyme myrosin is also present. The fatty oil gives the following values: saponification value 1.32 per cent, saturated acids 16.97 per cent. (palmitic acid 11.35, stearic acid 5.25, and arachidic acid 0.31 per cent.), unsaturated acids 78.63 per cent. (oleic 76.50 and linoleic 2.13 per cent.). The seeds yield a sulphur containing basic substance, carpasemine, $C_8H_{10}N_2S$, m.p. 165°C.; which has been identified as benzyl-thio-urea. A glycoside, carposide and an alkaloid carpaine, are found in the leaves. Carpaine is also present in the bark root and seeds but only in traces. Carpaine has formula $C_{14}H_{25}O_2N$ and melts at 121°C. The leaves contain vitamin C 286 mg. and vitamin E 36 mg. per 100 gm. A sinigrin-like glycoside probably identical with carposide and amyrosin-like enzyme are found in the roots. Analysis of the fresh latex the leaves, fruit, stem and roots gave: water 75 per cent., caoutchouc like substances 4.5, fat 2.4, and resin 2.8 per cent. An enzyme and traces of carpaine are also present.

PHARMACOLOGICAL ACTION OF CARPAINE.—Carpaine is a heart poison but not of the cardiac glycoside type. It lowers the pulse frequency and depresses the central nervous system; 5 mg./kg. body weight is said to be toxic to rabbits. It is also reported to be a potent amoebicide (Henry,). Merck lists carpaine hydrochloride as cardiac tonic and diuretic. A dose of 5 mg., when injected intravenously in experimental animals, causes only a slight fall of blood pressure which, however, returns to the normal level within a very short time. The action of the heart is depressed and both the ventricles and auricles show evidence of slight depression. The respiration is not depressed to any great extent. The volumes of the different organs are very slightly affected, if at all.

The alkaloid has not been used in therapeutics.

References:—

- (1) *Wealth of India: Raw Materials*, 1950, II. 79; (2) Krishnamurti and Giri, 1949, *Proc. Ind. Acad. Sci.*, 29B, 155; (3) Sanana and Ahmed, 1949, *Jour. Sci. Industr. Res.*, 8B, 35; (4) Panse and Paranjpe, 1943, *Proc. Ind. Acad. Sci.*, 140; (5) Wehmer, 1931, *Die Pflanzstoffe*, II, 807; (6) Henry, 1949, *The Plant Alkaloids*, 599.

CASSIA ABSUS Linn. (Leguminosæ)

VERN.—Arab.—*Chashmizaj*, *Chichm*, *Habessoudan*, *Tashmizaj*; Bomb.—*Chaksie*; Hind.—*Banar*, *Chaksi*, *Chaksu*, *Chakut*; Mal.—*Karinkolla*; Mar.—*Kankuti*; Sans.—*Arangakulitthika*, *Chipita*, *Drikaprasada*, *Kananottha*, *Kulattha*, *Kulmasha*, *Kumbhakarini*, *Lochanahita*; Pers.—*Chashmizak*, *Chashum*, *Cheshmak*; Tam.—*Edikkol*, *Karunganam*, *Kattukol*, *Mulanippalvirai*; Urdu.—*Chakshu*.

The plant is an erect annual, 1 to 2 ft. high having grey briskly, viscose hairs. It grows in the lower parts of the western Himalayas; it also occurs in Ceylon. The different parts of the plant are considered to have different properties. The leaves are believed to be hot, bitter and acrid and are used as an external application to tumours. They are also considered useful in cough, affections of the nose, hiccup, asthma and bronchitis. In the Hindu Materia Medica they are said to enrich blood. Both the Mohammedan and Hindu practitioners considered the seeds to be bitter, astringent to the bowels and diuretic. Applied locally they are believed to heal ulcers cure leucoderma and are beneficial in diseases of the eye and haemorrhoids. On the Gold Coast, the root is ground with Mako pepper and boiled in water. The liquor is then drunk with palm wine to cure constipation.

CHEMICAL COMPOSITION.—Siddiqui and Ahmad (1933) examined the seeds and isolated two water soluble quaternary bases chaksine and iso-chaksine as carbonates in 1.5 per cent. yield. The formula, $C_{12}H_{21}O_2N_3$, was assigned to them. Roy and Co-workers later showed that these bases have the formula, $C_{11}H_{21}O_3N_3$, and not the one assigned by previous workers. The seed oil contains oleic acid 16.32 per cent., linoleic acid 47.32, linolenic acid 0.41, hydroxy acids 0.75, palmitic acid 6.28, stearic 8.10, lignoceric acid 0.82, unsaponifiable matter 8.4, glycerol 10.4 and unidentified matter 1.2 per cent.

PHARMACOLOGICAL ACTION.—Preliminary experiments on the action of Chaksine sulphate using frog as test animal show it to be a great depressant of heart, respiration and nerve centres, the lethal dose being 0.1 gm. per kilogram. More detailed studies of this powerful alkaloid are indicated. The powdered seeds are largely used as a household remedy in ophthalmia in northern India. No work on scientific lines has been done to prove or disprove its effectiveness in this condition.

References:—

(1) Siddiqui, S., and Ahmad, R., 1935, *Proc. Ind. Acad. Sci.*, 421, 8; (2) Roy, J. N. Kapoor, H. R., and Narang, K. S., 1940, *Jour. Ind. Chem. Soc.*, 281; (3) Ahmad, Z., 1940, *Chem. Abst.*, 281.

CEDRELA TOONA Roxb. (Meliaceæ)

VERN.—Assam.—*Henduripoma*, *Jia*, *Poma*, *Tun*, *Tungd*; Beng.—*Lud*, *Tun*, *Tuni*, *Tunna*; Bomb.—*Deodari*, *Kudaka*, *Kuruk*, *Mahanim*, *Tunna*, *Tupa*; Eng.—*Happy tree*, *Indian mahogany*, *Moulmein*, *Cedar*, *Sandal neem*, *Toon*; Hind.—*Lim*, *Lud*, *Mahalimbu*, *Mahanim*, *Tuna*, *Tuni*, *Tunkajhar*; Kumaon.—*Tun*; Mal.—*Akil*, *Arana*, *Devabaram*, *Kacham*, *Kuberakam*, *Malaveppu*, *Sanakil*, *Tunnam*, *Vedivembu*; Mar.—*Deodari*, *Kuruk*;

Punj.—*Bisru, Chitisirin, Darab, Der, Deri, Dravi, Khanam, Khushing, Tun*; Sans.—*Apina, Kachha, Kachhaka, Kanta, Kantalaka, Mahanim, Nanda, Nandivriksha, Pituka, Pitaka, Tunnaka*; Tam.—*Ayil, Madagirvembu, Mali, Sandanavembu, Sevvagil, Tevadaram, Tunu*; Tel.—*Gali, Nandi*; Urdu.—*Tun*.

This is a tall handsome tree, about 50 to 60 ft. high found in abundance in the sub-Himalayan tracts from the Indus eastwards, Chittagong, Assam, Burma, Chota Nagpur, Western Ghats of Bombay to the Nilgiris and other hills of the Deccan Peninsula. It grows best in small gaps in forests and in such places it develops a tall clean bole 30–40 ft. in height. In the open it tends to branch lower down forming a large crown and a comparatively stout bole 12–14 ft. in height. The plant flourishes best in deep rich moist loamy soil. The maximum and minimum temperatures normally obtaining in its natural habitat are 110°F. and 30°F. respectively and the annual rainfall 45–160 in. It can however, be cultivated in localities in which the maximum temperature reaches 120°F. and the minimum temperature falls below 30°F. The annual rainfall may be as low as 30 in. The young plants need protection from the sun, and as the plants grow, overhead light and crown room are necessary for proper development.

Under natural conditions germination takes place soon after the seeds fall early in the rainy season. Clearing the ground around the seed bearers is beneficial for natural regeneration. In Bengal the plant has been successfully raised by direct sowing in lines or in gaps 30–40 ft. square in forest clearings. The seeds are collected in May off the trees and not from the ground as it has been observed that the percentage of germination in collections from the ground is low. Seeds are sown in raised nursery beds. Good results have been obtained in Dehradun by transplanting seedlings during the second rains. Toon, plants are subject to attack by the fruit and shoot borer *Hypsipyla rolousta*. The wood which is of a brownish red colour, has a faintly aromatic odour, mainly due to the presence of a golden yellow essential oil, and a lactone. The flowers yield a red and a yellow dye which are largely used in Mysore for dyeing. Besides its commercial aspects as a dye, the plant enjoys a great reputation in medicine. The Ayurvedic and Unani physicians consider the plant to have powerful astringent properties and use it in the treatment of ulcers generally and those of leprosy particularly. It is also considered beneficial in the treatment of gleet and scabies. The infusion of the bark is given in intermittent fevers and diseases of blood in Indo-China. To the seeds are attributed similar therapeutic properties. The flowers are considered emmenagogue in Bombay and are given in disorders of menstruation.

CHEMICAL COMPOSITION.—The flowers of *C. toona* contain a red colouring matter, nyctanthin, $C_{15}H_{18}O_8$ (m.p. 285–87°C.) identical with the colouring matter of the flowers of *Nyctanthes arboraristic* Linn. The flowers also contain a flavone or flavonol dyestuff, the identity of which has not been established. They contain quercetin, probably as glycoside. The flowers form the source of one of the less important natural dyestuffs known in Bengal as Gunari. Cotton and woollen fabrics can be dyed a dull yellow colour by mere immersion in a boiling extract of toon flowers, but the colour is not fast. Better results are obtained by the use of mordants. The flowers are used in conjunction with safflower and turmeric,

to produce the sulphur-yellow colour or 'Basanti'. The bark contains tannic acid, a bitter resin, citric acid, a phlobaphene-like compound and starch. No substance of alkaloidal nature has been detected. The ash is rich in calcium.

The essential oil from the wood was analysed by Pillay and Rao (1931). By steam distillation of the wood, a golden yellow pleasant smelling essential oil (yield 0.44 per cent.) was obtained. The oil was found to consist of a tricyclic sesquiterpene copaene (35 per cent.) and bicyclic hydrocarbons identified as cadinene. The sesquiterpene alcohol fraction consisted mainly of cadinol (13 per cent.). Parihar and Dutt (1950) while working on the wood of the plant isolated a pleasant smelling, heavy essential oil, reddish yellow colouring matter, m.p. 256°C. and a lactone cedrelone, m.p. 204°C. in yields of 0.17 per cent., 0.25 per cent. and 0.4 per cent. respectively of the dry wood.

The lactone cedrelone which crystallises in colourless, glistening, rhombic needles and large hexagonal plates from benzene has the formula, $C_{25}H_{30}O_5$. No clinical trials have been carried out to prove or disprove its medicinal properties.

References:—

- (1) *Wealth of India: Raw Materials*, 1948, 105; (2) Perkin and Everest, 1918, *The Natural Organic Colouring Matter*; (3) Whemer, 1931, *Die Pflanzenstoffe*, II, 658; (4) Pillay and Sanjiv Rao, 1931, *Jour. Soc. Chem. Industr.*, 220; (5) Parihar and Dutt, 1950, *Jour. Ind. Chem. Soc.*, 77.

CELASTRUS PANICULATUS Willd. (Celastraceæ)

VERN.—Beng.—*Lataphataki*, *Malkangni*; Bomb.—*Kanguni*, *Malkangni*; C. P.—*Kakundanrangul*, *Vahrangur*; Eng.—*Black oil tree*, *Climbing staff plant*, *Intellect tree*; Kumaon.—*Malangni*, *Malakoni*, *Mulkakni*, *Papkakani*; Mal.—*Palulavam*; Mar.—*Kangani*, *Malkangani*, *Malkangoni*, *Pigavi*; Punj.—*Sankhu*; Sans.—*Agnimasha*, *Amrula*, *Avega*, *Dipta*, *Durjara*, *Durmada*, *Gatida*, *Ingudi*, *Jyotishka*, *Jyotishmati*, *Phala*, *Paravatanghri*, *Paravatapadi*, *Pidya*, *Pinya*, *Supingala*, *Swarnalata*, *Triparni*; Tam.—*Adibaricham*, *Kalambam*, *Kagodagi*, *Kaligam*, *Kirumikkundram*, *Kungiligam*, *Kuvangundal*, *Mallagam*, *Sodiyam*, *Tipadisam*, *Valuluvai*; Tel.—*Bavanji*, *Erukata*, *Gundumcda*, *Malkanguni*, *Maneru*, *Pallerutiva*; Urdu.—*Malkanguni*.

It is a large deciduous climber which grows in the sub-Himalayan tracts extending from Jhelum (Punjab) to Assam, ascending to an altitude of 6,000 ft. The plant grows throughout the hilly parts of Bombay south of Gujrat and also in Central India and in Madras. Both in Ayurvedic and Unani medicine the seeds and oil are recommended in the treatment of rheumatism, gout, paralysis and leprosy. The oil is reputed to be a nerve stimulant and is considered as a brain tonic.

CHEMICAL COMPOSITION.—Broosma (1902) showed the presence of an alkaloid, a glycoside and colouring matter in the leaves. Kumarswamy and Manjunath (1936) investigated the seeds but could not obtain any satisfactory evidence for the presence of an alkaloid in the plant. They obtained 0.15 per cent. of steam volatile matter which had the characteristic odour of the seed cake. The seeds contained 52.2 per cent. of a thick brownish oil with an unpleasant taste. The oil has the following constants: n_D^{25} 0.9586 and n_D^{20} 1.4747, sap. value 239.2, acid value 44.4, iodine value 102.9, Richart Miesel value 62.8, acetyl value 130.1, unsaponifiable matter 5.7 per cent; Hehner value 75.2 per cent. The unsaponifiable matter

consisted of a small amount of phytosterol, m.p. 136°C. and large quantities of non-nitrogenous material, m.p. 61-61.5°C. which was neutral in character.

Warsi (1940) reported the presence of a different sterol (m.p. 184°C. yield 0.8 to 1 per cent.) from the same fraction and the presence of a bright colouring matter (2 per cent.) in the oil. It slowly decomposes in air and rapidly in the presence of mineral acids. Gunde and Hilditch (1938) found that the oil from seed and fruit coat contain appreciable proportion of formic, acetic and benzoic acid in addition to usual higher fatty acids. The three acids are present not as glycerides but as esters of tetrahydroxy water soluble alcohol, a pale yellow resinous solid, the nature of which was not determined. Shah and Co-workers (1947) obtained a semi-solid fat from the arils which yielded upon bleaching and crystallisation from ethyl alcohol a crystalline material m.p. 75°C. believed to be tetra-cosanol and a sterol m.p. 149°C. Basu and Pabrai (1946) isolated two alkaloids from the oil cake but none were found in the oil expressed from seeds. One alkaloid celastrine, $C_{19}H_{25}NO_3$, m.p. 260°C. was obtained in crystalline state in 0.0015 per cent. yield but the other which was named paniculatine could not be obtained in pure state. No work has been done so far on the pharmacology of the alkaloids isolated nor have its alleged properties in rheumatism and gout have been substantiated.

References:—

- (1) Broosma, 1902, *Bull. Inst. Bot. Buitenzorg.*, 17; (2) Kumarswamy and Manjunath, 1936, *Jour. Ind. Chem. Soc.*, 353; (3) Warsi, 1940, *Curr. Sci.*, 134; (4) Basu and Pabrai, 1946, *Jour. Amer. Pharm. Assoc.*, 272; (5) Gunde, B. G., and Hilditch, 1938, *J. C. S.*, 193; (6) Shah, Phalinkar and Bhide, 1947, *Curr. Sci.*, 57.

CEPHALANDRA INDICA Naud. (Cucurbitaceæ)

VERN.—Beng.—*Tela-kucha*, *Bimbu*; Hind.—*Bhimb*, *Kanduri-ki-bel*; Punj.—*Kanduri*, *Ghol*, *Kundru*; Guj.—*Ghobe*, *Gluru*, *Galedu*; Bomb.—*Tendli*, *Rantondla*, *Tenduli*, *Bhimb*; Mar.—*Zidabi*, *Tendli*, *Tondali*, *Bimbi*; Tam.—*Kovai*, *Kwai*; Mal.—*Kwel*, *Gwel*, *Kova*; Arab. and Pers.—*Kabarc-hindi*; Sans.—*Tondc-balli*, *Bimba*, *Kimbika*.

C. indica is a perennial creeping herb with long tapering tuberous roots and deep green leaves. It grows in a wild state abundantly in Bengal and in most parts of India. It has a smooth green fleshy fruit with an extremely bitter taste. When ripe the fruit becomes scarlet in colour and sweet to the taste and is sometimes eaten as a vegetable. The plant has the reputation in Bengal of having a remarkable effect in reducing the amount of sugar in the urine of patients suffering from diabetes mellitus. It has been described by some as the 'Indian substitute for insulin', and among the medical practitioners in Calcutta a strong belief exists as to its efficacy in glycosuria. The green juice extracted from the plant was tried in some of the surgical cases suffering from glycosuria in the Calcutta Medical College Hospitals with apparently beneficial results. The quantity of sugar was said to be greatly reduced and in some cases entirely disappeared. Previous to this, the drug is said to have been tried many years ago and some experimental work was also done in the Department of Physiology at the Medical College, but no record of this work could be discovered in the published literature. The origin of the belief that the drug has anti-diabetic properties can be traced to its use by the Ayurvedic physicians who give the fresh juice extracted from the tuberous

roots and leaves, either by itself or in combination with certain metallic preparations, in the treatment of diabetes.

CHEMICAL COMPOSITION.—The fresh plant was chemically analysed by the author and his co-workers. Not only was a search made for the ordinary active principles which are found in plants (e.g., glycosides and alkaloids) but bodies of the nature of hormones and enzymes which are sometimes present were also investigated. Dubbins and Corbett (1923) have shown that in certain plants and vegetables both the blood-sugar-reducing and blood-sugar-increasing principles are present. When the former are freed from the latter and are injected into normal rabbits they produce a fall of blood sugar typical of that caused by an injection of insulin. Collip (1923) isolated a substance called *glucokenin* which has the property of reducing the amount of sugar in the blood. The object in separating bodies of this nature from the *C. indica* was to see whether any such sugar-reducing principles were present. The method employed for separation of these bodies was principally the same as that used by Collip for isolating glucokenin. The fresh plant was crushed and the juice was expressed. To this twice its volume of alcohol was added, which precipitates the enzyme and chlorophyll. The enzyme was isolated by washing the precipitate with alcohol and drying in a vacuum. It was then treated with a small quantity of water which dissolved the enzyme. After filtering this, the enzyme was precipitated with twice its volume of alcohol and dried *in vacuo*. For the separation of the hormone, the solution after precipitation of the enzyme and chlorophyll was concentrated *in vacuo* at 60°C to a small bulk and filtered. It was then saturated with ammonium sulphate which precipitated the hormone; the precipitate was extracted with 70 per cent. alcohol. This was then filtered and the clear liquid was added to 40 volumes of 95 per cent. alcohol, neutralised and kept overnight. The precipitate which settled at the bottom was removed and dried. The solution after separation of the hormone was acidified with dilute sulphuric acid and shaken with ether to remove any oily substance and then made slightly alkaline with ammonia. The ammoniacal solution was shaken with chloroform, which took up the alkaloid, which was thus obtained by evaporation of the solvent. By use of this technique *C. indica* was found to contain an enzyme, a hormone and traces of an alkaloid.

PHARMACOLOGICAL ACTION.—The activity of the enzyme isolated was tested. It had well-marked amylolytic properties and rapidly hydrolysed starch. On the proteins it had no effect. The effects of subcutaneous injection of the hormone on the blood sugar were also tested in rabbits. The blood was examined for seven days after the injection of the hormone but besides the normal variations which usually occur, no marked effect was produced. The alkaloidal body was also tested but did not show any pharmacological action on the heart, respiration, blood pressure, and isolated uterus. Neither the alkaloid nor the enzyme had any sugar-reducing properties when administered to rabbits.

CLINICAL TRIALS.—The effect of the drug was tested on a series of diabetic patients who were selected at random as they came to the hospital for admission. The carbohydrate intake was fixed and kept strictly under control. The total quantity of urine in 24 hours was carefully collected and part of it was examined every day for the quantity of sugar. The blood sugar was also examined from time to time, the minimum fasting level after a total fast for 5 to 6 hours being determined in each case. The patients were regularly weighed during the entire period of the trial. After the patient was put on a strict diet of known carbohydrate value, some time was allowed for the daily output of sugar to run to a constant level. The patients were then put on a freshly-extracted juice of the stem and leaves of the plant, the dose being one to two ounces, every morning on an empty stomach. There was no reduction in the percentage of sugar excreted,

total sugar or blood sugar. Insulin was given to these patients after cephalandra was stopped and in three days the sugar entirely disappeared from the urine.

The apparent beneficial results obtained after administration of this plant are probably due to the fact that a large number of cases of so-called diabetes in this country are really cases of intermittent glycosuria and these patients often improve without any medical interference. The sugar may disappear entirely with variations in diet, exercise, etc. There was at least one example of it in this series in which there was apparent reduction of sugar in urine from 105 gm. to 54 gm. after five doses of the fresh juice of the drug. The drug was then stopped but the improvement in the patient continued and the sugar excretion was reduced to 5 cm. a day and the blood sugar to 0.182 per cent. after eleven days. On further investigation it was found that this was a very early case of diabetes having a very good tolerance for sugar. In another patient on the other hand, who was excreting only 14 gm. of sugar a day, even after eight days' treatment with the drug the daily sugar excretion, blood sugar and the weight of the patient remained practically unchanged. In yet another patient, the sugar value of the diet was 48 gm. and the sugar excretion per day was 45 gm. Fresh juice of the plant was tried for thirteen days with no effect but as soon as the diet was reduced by 10 gm. only the sugar disappeared. This shows clearly that *C. indica* could not even effect the utilisation of 10 gm. of carbohydrates.

THERAPEUTIC USES.—It is obvious from the above that administration of the fresh juice of this plant does not produce any reduction of the sugar either in the blood or in the urine in cases of diabetes and that any reduction that is met with is purely dietetic.

SUMMARY.—*Cephalandra indica* contains an enzyme with amylolytic properties, a hormone and traces of an alkaloid. None of these substances reduces sugar when administered subcutaneously to rabbits. Fresh juice extracted from the leaves, stem and root of the plant produces on reduction of sugar in the blood or urine of patients suffering from glycosuria.

References:—

(1) Chopra, R. N., and Bose, J. P., 1925, *Ind. Jour. Med. Res.*, 13, 11; (2) *Health Bull.*, 1941, No. 23, 39; (3) Krishnamurti and Giri, 1949, *Proc. Acad. Sci.*, 155; (4) Sadna and Ahmed, 1949, *Jour. Sci. Industr. Res.*, 35; (5) Pense and Paranjpe, 1943, *Proc. Indian Acad. Sci.*, 140.

CERBERA ODOLLAM Gaertn. (Apocynaceæ)

Syn. *Cerbera manghas* Linn.

VERN.—Beng.—*Dabur, Dhakur*; Mad.—*Kadalalari*; Mar.—*Sukanu*; Mal.—*Chattankaya, Ponna, Othalam, Utalam*; Tam.—*Kadalma, Kattarali, Kattuma, Udalai*.

It is a small tree with whorled branchlets, terminal leaves, large odorous flowers and long, green fruits of the type of drupes. The plant is found all over India, particularly in salt swamps. It grows abundantly on the Malabar coast. It also occurs in Ceylon and Burma. The plant is intensely poisonous and has been named after the watch dog of the infernal regions whose bite was reputed to be poisonous. The bark is utilized for the manufacture of a fibre. The seeds yield an oil used by the Burmese for anointing the head and for burning in oil lamps. The whole plant is very rich in a milky sap in which most of the medicinal properties of the

plant reside. The sap as well as the leaves possess emetic and purgative properties. The bark also contains a highly toxic cathartic principle. The bud is believed to be a narcotic and the green fruit is poisonous to dogs and fish (Pammel, 1911). The kernel of the fruit is highly irritant and, when given internally produces vomiting, purging and collapse. The juice was formerly used in Madagascar for criminal purposes.

CHEMICAL COMPOSITION.—From the kernels of the seeds, De Vry (1864) isolated the glycoside cerberin, $C_{27}H_{40}O_8$, m.p. $191-92^{\circ}C$. It is present in the seeds to the extent of 0.08 to 0.16 per cent. It is soluble in chloroform and alcohol, sparingly in water, ether and petroleum ether. The plant contains a second poisonous bitter glycoside odollin. The seeds also contain 43.1 per cent. of non drying oil which consists of linolic acid 16.4 per cent. palmitic 30, stearic 9.9, oleic 4.2, myristic 0.4, lignoceric 0.9 per cent. and unsaponifiable matter.

PHARMACOLOGICAL ACTION.—Cerberin is sparingly soluble in water and its saturated solution has approximate concentration of 1 in 5,000 only. This solution is non-irritant to the skin, conjunctiva and subcutaneous tissues but produces vomiting, diarrhoea and even syncope in animals if given by subcutaneous injection. The lethal dose was found to be 1.8 mg. per kilo body weight for the dog, 3.1 mg. for the cat and 50 mg. per kilo for the rabbit. The main effect of the glycoside is on the cardiovascular system. In high dilutions cerberin has a marked cardiotonic properties, the amplitude of ventricular contractions being increased but the rhythm remained unchanged. At higher concentrations initial stimulation is followed by gradual depression and finally bradycardia sets in. The action generally resembles to some extent that of the digitalis glycosides. It would be interesting to detail these studies both clinically and experimentally and ascertain if it could take any place as a digitalis substitute in therapeutics.

On the carotid pressure the action of cerberin is biphasic. It first depresses and then produces a rise of the blood pressure. It would appear that the initial fall is purely vagal as it disappears on atropinization. The secondary rise is more likely to be due to the direct effect of the drug on the myocardium. On the plain muscle of the intestine, cerberin acts as a definite stimulant both with regard to its tone and peristaltic movements. This action is somewhat similar to that of pilocarpine. Atropinization removes this vagal action and pilocarpine potentiates it. The above mentioned stimulating action of cerberin on the intestinal musculature could justify its empirical use as a cathartic. Chen and Steldt (1942) showed that cerberin can be isolated from both the oil and the defatted kernels of the nuts of the plant. From one lot of nuts a glycoside similar to but not identical with cerberin was isolated. The name cerberoside has been given to it. It has formula, $C_{41}H_{70}O_{20}$, and melts at $187.5-88.5^{\circ}C$. Cerberoside is less active than cerberin and both cerberin and cerberoside have digitalis like action. Cerberin is several times as potent as cerberoside in cats and frogs but only slightly more active than cerberoside in producing vomiting in pigeons. This plant is too poisonous to be used in therapeutics. It has not been used by the practitioners of indigenous medicine nor as household remedy, in any part of India.

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(1) Dymock, Warden and Hooper, 1891, *Pharmacographia Indica*, 2, 410; (2) Chopra, R. N., Bose, B. C., Gupta, J. C. and Chopra, I. C., 1942, *Ind. Jour. Med. Res.*, 107; (3) De Vry, 1864, *Ber. de Kais. Akad. d. Wiss. Wein*, 16; (4) Chen, K. K., and Steldt, F. A., 1942, *Jour. Pharmacol.*, 167.

CICHORIUM INTYBUS Linn. (Compositæ)

VERN.—Arab.—*Hindubar*, *Indyba*; Eng.—*Bunk*, *Chicory*, *Succory*, *Wild endive*, *Wild cicory*, *Wild succory*; Guj.—*Kasani*; Hind.—*Kasni*; Pers.—*Kasni*; Punj.—*Gul*, *Hand*, *Kasni*, *Suchal*; Tam.—*Kashini*; Tel.—*Kasini*; Urdu.—*Kasani*.

This herb belongs to the Compositæ family. It is a native of the western hemisphere but grows in a state of nature in the north-western parts of India. The plant has been successfully cultivated in Nadiad, Broach and Amalsad in Bombay State. It is grown either for fodder or as is more often the case, for the roots which form an article of commerce. The plant appears to grow on any type of soil. Sandy loam is, however, considered to be the best provided there is adequate evenly distributed rain-fall and irrigation is possible. For obtaining a good harvest of the root, the soil should be deep, fertile and easily workable with good drainage. The growing season lasts for six months and the crop demands a good deal of attention and manual labour. For raising Chicory as a fodder or salad crop, the seeds are sown broadcast (7–12 lb. per acre) on a well prepared field. Drilling about 6 in. apart in rows, separated from each other by 9 in. is, however, to be preferred. The crop once sown lasts for 5 to 10 years.

To obtain the root crop the practice in New Zealand is to sow the seed in mid-October on prepared ridges 22 in. apart; 2-2½ lb. of seeds are required per acre of land. It is essential to eliminate all weeds completely during the early period of growth. At the end of May, the foliage which is palatable and nutritious is fed to sheep. The roots are lifted as soon as they are ripe with a special type of plough and left in the field for 14 days. If delayed they become fibrous and lose weight even though they may increase in size. The average yield in New Zealand is 10-11 tons per acre while in India it is considerably lower. The plant is not usually allowed to seed before the collection of the root. The root is either sun-dried or kiln-dried, although sun-dried root has a better appearance, kiln-drying is better and is preferred. The dried root after roasting and powdering is used for mixing with coffee. There are two varieties of this species:

(1) The cultivated sweet variety has tonic properties is considered cooling and quenches thirst. It is used in indigenous medicine as local application to cure acne, opthalmia and inflammation conditions of throat. It is considered beneficial in enlargement of the spleen, vomiting of fevers and diarrhoea. The root is the best part of the plant and has aromatic and diuretic properties. It is believed to purify and enrich blood, lessens inflammation and pain in the joints. The leaves are applied locally to lessen pain of inflamed joints. The seeds are considered as a tonic to the brain, appetiser and are believed to relieve headache and asthma.

(2) The wild bitter variety is considered a tonic, emmenagogue and astringent to the bowels. It is believed to cure asthma and enriches the blood. The seeds are considered carminative and cordial. A decoction made from the plant is used in delayed menstruation and for checking bilious vomiting.

According to Hughes-Beller, in Loralai, the plant is used as a cure for diarrhoea and bilious attacks.

CHEMICAL COMPOSITION.—Nietzki (1876) separated from the flowers of the plant the glycoside cichorin, $C_{32}H_{32}O_{19}$, m.p. $215-220^{\circ}C$. which is obtained in colourless needles from water. Dutt and Misra (1937) examined the seeds. When burnt these yield 13.8 per cent. of a greyish white ash consisting of 17.5 per cent. of water soluble and 82.5 per cent. of water insoluble inorganic material containing mainly potassium, sodium (traces), calcium, aluminium sulphates, phosphates, chlorides, carbonates and silica. They also isolated a semi-drying oil which is optically inactive and on further investigation was shown to be a mixture of unsaturated oleic and linolic acids and saturated stearic and palmitic acids. The unsaponifiable matter was further examined and found to contain phytosterol, m.p. $131-133^{\circ}C$. Analysis of fresh roots of chicory gave, water 77.0 per cent., gummy matter 7.5 per cent., glucose 1.1 per cent., bitter extractive 4.0 per cent., fat 0.6 per cent., cellulose, inulin and fibre 9.0 per cent. and ash 0.8 per cent. The ash of the roots (and also of the leaves) is rich in potash. The bitter principle is probably a glycoside of fructose and pyrocatechuic acid to which the formula, $C_{18}H_{20}O_6$, has been assigned. The presence in the juice of the roots of a stearin, mannite and tartaric acid has been reported. Betaine and choline are also present in small quantities. During the storage of chicory roots, inulin is partially converted to inulide and fructose indicating the presence of an enzyme which brings about the transformation, inulin- inulide-fructose. Another enzyme, inulo-coagulase, which coagulates inulin in the expressed juice of the roots is also reported to be present (Thorpe, III, 30).

Chicory is devoid of caffeine and tannins (Oliver 1932). Chicory gives a characteristic odour on roasting. The volatile matter contains acetaldehyde, acetone, diacetyl, diketopentane, furfuraldehyde, 5-hydroxymethyl-furfuraldehyde maltol, furan, methyl and furfuryl alcohols, and acetic, pyruvic, lactic, pyromucic and palmitic acids, together with traces of phenol and a neutral oil (Thorpe, loc. cit). There is considerable destruction of inulin during the process of roasting but the product contains increased proportions of reducing sugars together with dextrin and caramel. The concentration of chicory in blended coffee can be ascertained by determining the cupric reducing power of the extract. Roasted coffee contains 1.9-2.6 per cent. while chicory contains 25-27 per cent. of reducing sugars. The tinctorial power of chicory is roughly 3 times that of coffee, and an approximate idea of the composition of mixtures of coffee and chicory is possible on the basis of the tinctorial power of the infusion. The determination of specific gravity of extracts also provides a means of detecting chicory in coffee blends. Whereas the specific gravity of coffee infusions varies from 1.0080 to 1.0090 that of chicory infusions lies between 1.01910 and 1.02326.

Chicory is sometimes adulterated with sugar beet (*Beta vulgaris* Linn.). The adulteration can be easily detected by determining the betaine content. Sugar beet contains approximately 7 times as much betaine as chicory. Chicory has not been assigned any medicinal properties in Western medicines. Its alleged properties in the indigenous medicine have not been verified.

References:—

(1) Neethling and Spamer, 1929, *Bull. Dep. Agric., S. Afr.*, No. 70; (2) Richards, N. Z. J., 1944, *Agric.*, 69, 581; (3) Nietzki, 1876, *Arch. Pharm.*, 327; (4) Dutt, S. and Misra, R. N., 1937, *Jour. Ind. Chem. Soc.*, 141; (5) *Wealth of India: Raw Materials*, II, 162; (6) Oliver, 1932, *Tea Coffee Tr. J.*, 443.

CISSAMPELOS PAREIRA Linn. (Menispermaceæ)

VERN.—Beng.—*Akanadi, Nemuka, Tejomalla*; Bomb.—*Pahadmul, Pahadvel, Venivel*; Eng.—*False pareira brava, Velvet-leaf*; Hind.—*Akanadi, Dakhnirbissi, Harjeuri, Pari*; Mal.—*Kattuvalli, Patuvalli*; Sans.—*Ambashtha, Ambashthika, Avidhakarni, Brihattikta, Devi, Ekashihila, Kuchela, Laghupatha, Mahanjasi, Papacheli, Patika, Prachina, Pratanini, Ruchishya, Shishira, Shreyasi, Sthapini, Suthira, Tikta-pushpa, Trivrita, Uthika, Vallika, Vridhakarnika, Vriki, Vrittaparni*; Tam.—*Appatta, Punaittila, Puttutiruppi, Sina, Tuvan, Vattattiruppi*; Tel.—*Adivibankatige, Pata, Visaboddi*.

It is a climbing shrub distributed throughout tropical and subtropical India and warm parts of Asia, East Africa and America. The root is a common bazar medicine sold under the false name *Parcira brava*. It was sometimes confused with the true pareira derived from *Chondrodendron tomentosum* a native of Peru and Brazil. In the Hindu Medicine the root is considered bitter, relieves pain and is useful in febrile conditions, dysentery and heart troubles. In Charaka and Sushruta the root in combination with other drugs is recommended for the treatment of snake bite and scorpion sting. Mhaskar and Caius, however, showed that the root is not an antidote to snake venom and scorpion sting. The Mundas of Chota Nagpur use it in the treatment of stomach pain and diarrhoea, the root being ground and mixed with water. In French Guinea the roots are used as a diuretic in cases of dysuria and calcular nephritis. The root is said to act as an antiseptic in the bladder and is used in chronic inflammation of the urinary passages. The leaves are said to have a peculiarly cooling effects and they are used locally in cases of unhealthy sores and sinuses.

CHEMICAL COMPOSITION.—Wiggins (1840) isolated an amorphous alkaloid from the roots of the South American plant to which the name pelosine was given. It belongs to the isoquinoline group, m.p. 213°C. and has formula, $C_{36}H_{38}O_6N_2$. Scholtz (1896) showed that pelosine is identical with berberine. Besides the alkaloid the plant contains a saponin and abundance of tertiary ammonium basis. Bhattacharya and Co-workers (1952) investigated the roots and isolated two new bases hayatin and hayatinin besides quercitol and sterol m.p. 140-41°C. Hayatin, $C_{18}H_{15}O_3$ (OCH₃) NCH₃ m.p. 286°C. crystallises in rectangular plates from aqueous pyridine. Hayatinin m.p. 163°C. is a subsidiary base which crystallises in hexagonal plates from chloroform or acetone.

PHARMACOLOGICAL ACTION.—Floriana (1936) investigated the plant and found that it contains alkaloids, saponin, sugar and organic acids. The active principles have low toxicity. In the isolated heart first increase of tonus and then decrease of amplitude is produced. Larger doses cause paralysis and stoppage in diastole. The respiration is accelerated for a short time. The curariform activity of hayatin hydrochloride, methiodide and methochloride was tested on dogs anaesthetised with phenobarbitone, whose gastrocnemius muscle was made to contract 12 times per minute in response to electrical stimulation of sciatic nerve. From the depression of contraction caused by the substance, the curariform potency was assessed. While hayatin hydrochloride was found to have no effect on such preparation, hayatin methiodide and methochloride caused depression of contraction

of gastrocnemius to a very great extent. Hayatin methiodide and methochloride produce a fall of blood pressure which is prevented by the antihistamine drug phenergan (promethazine). Hayatin methiodide in smaller doses at first depresses and then stimulates the respiration, both the frequency and amplitude being increased. In higher doses paralysis is produced. No definite action has been found on the intestine or uterus. According to Pradhan and De (1953), hayatin methiodide causes paralysis of skeletal muscles in cats and dogs in the same manner as d-tubocurarine chloride. The curariform activity of hayatin methiodide is 1.14 times greater than that of d-tubocurarine chloride. The margin of safety for both the drugs is very low and the duration of curariform activity for both the compounds seems to be approximately the same. Neostigmine antagonises the curariform action of both hayatin methiodide and d-tubocurarine chloride. Acute toxicity of the drug was tested on albino rats (80-120 gm.); LD50 was calculated to be 0.31 mg/kg. This drug contains powerful active principles of therapeutic value and deserves the attention of Pharmacologists and Chemists.

References:—

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CLEOME ICOSANDRA Linn. (Capparidaceæ)

Syn. Cleome viscosa Linn.

VERN.—Arab.—*Bantakalan*; Beng.—*Hurhuria*; Bomb.—*Hurlhuria*, *Kanphuti*, *Pivalatilavana*; Hind.—*Hulhul*, *Hurhur*, *Hurhurch*, *Jangliharrrar*, *Kanphytia*; Mal.—*Ariavila*, *Katkudagu*; Mar.—*Harhuria*, *Kanphodi*; Punj.—*Bugra*, *Hulhul*; Sans.—*Adityabhakta*, *Arkabhakta*, *Arkakanta*, *Barbara*, *Mandukaparni*, *Manduki*, *Raviprita*, *Ravishla*, *Sauri*, *Satyanamni*, *Suryalata*, *Suvarchala*, *Suteja*, *Tilparni*, *Vikranta*; Tam.—*Nayikadugu*, *Nayivelai*; Urdu.—*Hulhul*.

It is a common weed which occurs throughout the greater parts of India, appearing chiefly in the rainy season. It is commonly found in Bengal and south India. This plant has long been in use in India as a household remedy. According to Mohideen Sheriff, the seeds are anthelmintic, rubefacient and vesicant. In this respect they are regarded as superior to the mustard seeds and equal to the European mustard. According to O'Shaughnessy, the whole plant is used in Cochin China as a counter-irritant giving rise to blisters when applied locally to the skin. In the United States, the root is said to be used as a vermifuge. According to Hindly, the seeds are given occasionally in the treatment of febrile conditions and diarrhoea.

CHEMICAL COMPOSITION.—Gupta and Dutt (1938) examined the seeds of this plant and isolated a fixed oil (36.59 per cent.) which on standing deposited a crystalline substance which was found to be a mixture of myristic acid, palmitic acid and a new acid, viscoside acid. This new acid, m.p. 97°C., seems to be an unsaturated fatty acid having the molecular formula,

$C_{27}H_{52}O_3$. From the alcoholic extract of the seeds a new flavone, called by authors Viscosin, m.p. 294-295°C. (decomp.) and yield 0.04 per cent. has been isolated.

No work has so far been done on the pharmacology of this plant, nor have the therapeutic claims with regard to its anthelmintic and rubefacient properties been substantiated.

References:—

- (1) Mahadeo Prasad, and Dutt, 1938, *Jour. Ind. Chem. Soc.*, 15, 593.

CLERODENDRON INFORTUNATUM Linn. (Verbenaceæ)

VERN.—Hind.—*Bhant*; Beng.—*Bhant*; Bomb.—*Bhat*; Sans.—*Bhantaka*;
Tam.—*Perugilal*; Tel.—*Gurrapukattiyaku*; Mal.—*Pcruku*.

This is a shrub with pinkish-white flowers which grows commonly in waste lands throughout the greater part of India and Burma, and in the damp forests of Ceylon upto an altitude of 5,000 ft. above sea-level. It grows gregariously, forming dense under-vegetation. The calyx becomes scarlet and the plant is then even more attractive than when covered all over with its foetidly scented flowers. The importance of this plant from medicinal point of view was advocated by number of observers as a vermifuge, anthelmintic and also as a cheap and efficient substitute for chireta. The leaves enter into the composition of pills used by the Mundas of Chota Nagpur in chest troubles where there is cough and difficult expectoration. In Charaka and Sushruta the root is recommended in the treatment of snake bite and the leaves against scorpion-sting. Mhaskar and Caius, however, showed that neither of these act as an antidote against snake venom or scorpion venom.

CHEMICAL COMPOSITION.—A systematic chemical investigation of the plant was carried out by Banerjee (1937) who found that the leaves contain ash 8.04 per cent., protein 21.1 per cent., crude fibre 14.84 per cent., free and reducing sugars 3.00 per cent., and total sugars after inversion 17.05 per cent. The ash of the leaves showed, ash soluble in water 45.08 per cent., ash soluble in acid 47.57 per cent., insolubles SiO_2 , MnO_2 , Fe_2O_3 , P_2O_5 , CaO , total alkali (Na_2O , K_2O) Cl , SO_3 , CO_2 . The leaves were found to contain, a bitter substance clerodin, a sterol and a fixed oil. No substance of alkaloidal nature was found to be present. The bitter substance clerodin, $C_{13}H_{18}O_3$, m.p. 161-162°C., crystallises from 50 per cent. alcohol in colourless long glistening needles in 0.12 per cent. yield from the dried leaves. The sterol was obtained as hexagonal plates, m.p. 127-138°C., from 80 per cent. alcohol in 0.01 per cent. yield. The alcohol (m.p. 75°C.) was obtained in extremely small quantity in flakes from the mother liquors after the separation of sterol. The fixed oil mainly consisted of linolenic, oleic and lignoceric acids. Different parts of the plant contain different quantities of clerodin. Young leaves and twigs collected before rains 0.12 per cent., after rains 0.55 per cent., old leaves 0.05 per cent., stem and roots traces only

PHARMACOLOGICAL ACTION.—The bitter substance clerodin has no haemolytic action on human red blood corpuscles and possesses no bactericidal property as tested against *E. coli*, the most common member of the intestinal flora. Clerodin is toxic to lower orders of life. The aqueous solutions of the substance kill earthworms within 30 minutes and small fish *Opdocheilus melastigma* in half an hour and also mosquito larvae in two hours. When given to rabbits it did not produce any injurious effects. It may, therefore, act as a vermifuge without

producing an injurious effects on the host though its action in this respect is not very marked.

References:—

(1) Bannerjee, H. N., 1937, *Jour. Ind. Chem. Soc.*, 51; (2) Bannerjee, H. N., 1936, *Sci. and Culture.*, 163.

CROCUS SATIVUS Linn. (Iridaceæ)

SAFFRON

VERN.—Arab.—*Jafrana, Zahafaran*; Beng.—*Jafran*; Eng.—*Saffron, Saffron crocus, Spanish saffron*; Hind.—*Larkimasa, Zaafaran*; Sans.—*Agnishekhara, Agnishikha, Aruna, Asra, Asrika, Balhika, Chandana, Charu, Dhira, Dipaka, Gaura, Ghasra, Ghusruna, Harichandana, Jaguda, Kaisara, Kaleyaka, Sankocha, Sankochapishuna, Raja, Rakta, Vasenya, Vira*; Tam.—*Kungumapu*; Tel.—*Kunkumapave*; Urdu.—*Jafranekar*.

Saffron is an onion-like plant about 1½ ft. high commonly found in Kashmir and around Quetta. The saffron of commerce consists of the dried stigma and tops of styles of the flowers of *C. sativus*. The plant does not appear to be indigenous to India but has been cultivated in Kashmir and recently also in Quetta. It may be propagated from seeds and offsets of bulbs. Saffron thrives well in cold regions with warm or sub-tropical climate. It requires a rich well drained, sandy or loamy soil. The plant is propagated vegetatively by bulbs. In Kashmir (Pampur, near Srinagar), bulbs are transplanted in August to September in raised plots (5 ft. square) surrounded by drains 9 in. in width, laid out in well-pulverized soil. The plots are hoed and weeded. No manure is applied nor is irrigation necessary once the plants are established. In Kishtwar in the Jammu Province where the soil is lighter and well-drained, the bulbs are planted on flat ground. Bulbs once established continue to live for 10 or 15 years, new bulbs being produced annually and the old ones rotting away gradually. About 50 mds. of bulbs are required to plant one acre. In good soils, the bulbs multiply to about 62.5 mds. in 3 years and to double their weight in 10 years. (Maund=82 lb.).

The yield of saffron both in Kashmir and Jammu is much lower than in other countries, where it is as high as 8-10 lb. per acre. Irrigation and application of suitable fertilizers probably accounts for higher yield. Saffron is largely cultivated as an irrigated crop in Spain. In France saffron is uprooted every three years and in Italy it is grown as an annual crop.

The flowers are picked very early in the morning when half open. The stigmata are then separated and at once transferred to sieves, placed on earthen kilns or pots containing a slow fire. Gentle heat has to be applied otherwise the material gets soft and deteriorated. Saffron is frequently adulterated with styles, anthers and parts of corolla of saffron. Exhausted saffron flowers and floral parts of some of the Compositae-like *Calendula* species and *Carthamus tinctorius*, corn silk, and various materials coloured with coaltar dyes, are also used as

household remedy and is said to be beneficial in common cold. The fresh juice from the rhizome, a paste prepared from it or a decoction made from the plant, is often used as a local application as well as internally in the treatment of leprosy, snake-bite, vomiting of pregnancy and affections of the liver. Murray advocate its use in troublesome diarrhoeas. Baden Powell found it to be effective in intermittent fevers and dropsy. The fresh juice from the rhizomes is believed to have anti-parasitic property in many skin affections. Externally it is used for indolent ulcers and a paste made from the powdered rhizomes along with caustic lime forms a soothing remedy for inflamed joints. A decoction made from the rhizome is said to relieve pain of purulent ophthalmia. It is still a common practice in India to use a piece of cloth soaked in turmeric solution for wiping away discharges of acute conjunctivitis and ophthalmia. Finely powdered turmeric mixed with alum forms a common household remedy for otorrhoea. A thick watery paste of 'haldi' is used for sprinkling on many auspicious occasions amongst the Hindus in this country in place of saffron because of its colour. The smoke produced by sprinkling powdered turmeric over glowing charcoal is said to relieve pain due to scorpion bite.

CHEMICAL COMPOSITION.—Analysis of Indian turmeric gave the following values: moisture 13.1, protein 6.3, fat 5.1, mineral matter 3.5, fibre 2.6, carbohydrates 69.4 per cent., and carotene calculated as vitamin A, 50 I. U./100 g. (Health Bull. No. 23, 1941, 37). The essential oil (5.8 per cent.) obtained by steam distillation of dry rhizomes has the following constants: Specific gravity 0.929, refractive index 1.5054, ester value 3.2, and acetyl value 26.3. It contains alpha phellandrene 1, sabinene 0.6, cineol 1, borneol 0.5, zingiberene 25 and sesquiterpenes (turmerones) 53 per cent. A ketone, $C_{13}H_{20}O$, and an alcohol, $C_9H_{11}OH$, identified as tolylmethyl carbinol, have been obtained from the volatile distillate. The crystalline colouring matter curcumin (yield 0.6 per cent., m.p. $180-183^\circ$) is a diferuloyl methane of the formula, $C_{21}H_{20}O_6$. It dissolves in concentrated sulphuric acid giving a yellow red colouration. The antioxidant properties of curcuma powder are probably due to the phenolic character of curcumin. The choleric action of the essential oil is attributed to tolylmethyl carbinol. The dyestuff acts as a cholagogue stimulating the contraction of the gall bladder.

PHARMACOLOGICAL ACTION.—Action on Bacteria: The bacterial properties of the oil were tested on *Staphylococcus albus* and *aureus*, and *B. typhosus*. The growth of cultures of *Staphylococcus aureus* and *albus* was inhibited in concentrations up to 1 in 5,000. The growth of cultures of *B. typhosus* was not inhibited even in a concentration of 1 in 1,000. The essential oil has a strong aromatic odour and applied locally it has a slightly irritant action on the unbroken skin. Applied to the mucous membranes it produces well-marked vasodilatation.

ACTION ON THE GASTRO-INTESTINAL TRACT.—Carminative Effect: Taken by the mouth, the solution of the oil has warm aromatic taste and promotes the flow of saliva. Taken internally in doses of 5 to 10 minims suspended in water, the oil gives a feeling of warmth and a sense of comfort in the stomach. It, therefore, seems to act as an appetiser, stomachic and tonic. The results obtained after fractional test meal on different individuals show that the administration of curcuma oil is followed by a marked diminution of secretion of the acids in the stomach.

The essential oil in 1 to 2 doses of a 1 per cent. solution at first produced a slight increase of the tone followed by subsequent relaxation of peristaltic movements. The oil injected in different doses intravenously in cats under urethane and chloralose anaesthesia, produced a fall in blood pressure. With smaller doses, such as 1 or 2 c.c. of a 1 per cent. solution of the oil, the fall in blood pressure was abrupt but recovery was also rapid. The fall in arterial blood pressure was always followed by a decrease in the volume of the intestine and the spleen but with an increase in the limb volume. The redistribution of the blood, therefore appears to be directed towards the peripheral blood vessels which are dilated.

ACTION ON THE HEART.—Myocardiograph experiments in the anaesthetised cats showed stimulation of the auricles with dilatation of the ventricles. Injections of larger doses such as 2 c.c. to 5 c.c. however, resulted in the diminution of the amplitude of contractions of both the auricles and the ventricles. The effects of the essential oil were also studied on the respiration of cats under urethane anaesthesia. An increase in both the rate and amplitude of the respiratory movements was obtained with smaller doses such as 1 c.c. or 2 c.c. of 1 per cent. solution of the oil.

Besides its use as a spice, curcuma is used as a household remedy for local application in inflammatory conditions and other painful affections. Whatever action it possesses is due to the antiseptic action of the essential oil and its irritant effects.

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 (2) *Hand Book of Commercial Information*, 1937, 330; (3) Kelkar and Rao, 1933, *J. Ind. Inst. Sci.*, 7; (4) Mayer and Cook, 1948, *Chem. Abst.*, 8496.

CURCUMA ZEDOARIA Rosc. (*Zingiberaceæ*)

VERN.—Arab.—*Zurambad*; Beng.—*Ekangi*, *Kachura*, *Sati*, *Shori*; Bomb.—*Kachura*; Eng.—*Zedoary*; Guj.—*Kachuri*; Hind.—*Kachura*, *Kalihaladi*; Mal.—*Kachcholam*, *Kachchurikizhanna*, *Pulakizhanna*; Pers.—*Kazhua*, *Urukelfafur*; Sans.—*Dravida*, *Durlabha*, *Gandhamulaka*, *Gandhasara*, *Jatala*, *Kalpaka*, *Karchura*, *Karshya*, *Shathi*, *Vedhya*; Tam.—*Kichilikilhangu*, *Pulankilhangu*; Urdu.—*Kachura*.

This plant grows in a state of nature in the Eastern Himalayas and in the moist deciduous forests of the coastal tract of Kanara. It is a native of north-east India and is widely cultivated in many Indian States, Ceylon and China. The plant is propagated by tubers. The rhizomes are cut into small pieces bearing buds, and planted in raked soil at the beginning of the monsoon. Arecanut plantations which provide shady conditions and banks of irrigation channels, afford congenial conditions for the cultivation of *C. zedoria*. A two year rotation provides sufficient time for the full development of the rhizomes. *C. zedoaria* closely resembles *C. longa* in appearance. The plant grows to a height of about 1½ ft. and bears green leaves with brownish purple veins. The rhizomes are large

and fleshy. They are cut into thin transverse section and dried. Dried slices, usually of a greyish buff colour and possessing an agreeable musky odour with a camphoraceous note, form the article of commerce. They have a pungent and somewhat bitter taste.

The tubers are rich in starch. The shoti* starch of commerce is a product prepared from its tubers and used as a substitute for arrowroot and barley. It is highly valued as an article of diet, especially for infants and convalescent. The rhizomes of commerce come primarily from Ceylon where the leaves of the plant are a favourite vegetable with the natives. The rhizomes possess aromatic, stimulant and carminative properties and are employed in the indigenous medicine as stomachic. Externally they are also applied to bruises and sprains. The root is chewed to correct a sticky taste in the mouth and is also an ingredient in some of the strengthening conserves which are taken by women after child birth. In cold it is given in form of decoction with long pepper, cinnamon and honey; pounded roots are applied as a paste to the body for their soothing affects. In Cambodia the rhizomes are used internally as stimulant and tonic. The rhizome in the form of tincture is administered in malaise and vertigo. A tincture prepared from the rhizome is given after pregnancy to women during the two weeks which follow delivery. The corms are chewed by Cambodian mothers who then apply them together with their saliva to the head and body of children suffering from convulsions. The leaves are used as a plaster in lymphangitis, furunculosis and adenitis. The rhizomes were tested by Caius and Mhaskar and were found not to have the alleged antidote action against scorpion venom.

CHEMICAL COMPOSITION.—Analysis of commercial sample of 'shoti' starch gave the following values: moisture 13.1 per cent., ash 1.01 and starch 82.6 per cent. Nearly a third of starch is amylose (Mukerjee and Co-workers 1945). Microscopic examination shows that 'shoti' starch granules resemble closely those of arrowroot starch. The starch forms a highly viscous paste with water. The dry rhizomes upon distillation yield 1 to 1.5 per cent. of an essential oil. Bacon (1910) obtained 0.1 per cent. of oil presumably from the fresh roots growing in the neighbourhood of Manila.

The oil is somewhat viscid liquid and its odour reminds one of ginger oil, but differs from it by camphor-like odour due to the presence of cineol. The oil has d_{15}^{20} 0.982 to 1.01, $\alpha_D^{20} +8$ to $+17^\circ$, n_D^{20} 1.50233 to 1.50556, acid value 16 to 21, ester value after acetylation 56 to 66. It is soluble in 1.5 to 2 volumes of 80 per cent. alcohol. The lower boiling fraction of the oil contains cineol, the high boiling fraction contains a sesquiterpene alcohol of a strong rather pleasant odour which imparts a characteristic aroma to the oil. In addition to the volatile oil, the roots also contain the yellow colouring matter curcumin, starch and sugars. Rao studied a commercial sample of oil from Krela Soap Institute, Calicut, and found that it contained pinene 1.5, camphene 3.5, cineol, 9.6, camphor 4.2, and borneol 1.5 per cent.

PHARMACOLOGICAL ACTION.—The action of the essential oil from this plant generally follows the lines of action of other essential oils. It acts as a carminative and produces relaxation of the smooth muscle of the intestine. The heart is somewhat depressed and the blood vessels contract. Both the frequency and amplitude of the respiratory movements is stimulated.

*It is the Bengali name given to the starch prepared in Bengal.

What therapeutic action the rhizome possesses is due to the presence of essential oil and starch.

References:—

(1) Daneshwar, 1940, *Ind. For.*, 479; (2) Mukherjee and Bhattacharya, 1945, *Jour. Ind. Chem. Soc., Ind. & News Ed.*, 4; (3) Bacon, 1910, *Philippine J. Sci.*, 261; (4) Gildemeister and Hoffmann, 1916, *The Volatile Oils*, 272; (5) Sanjiv Rao, Sudborough, and Watson, 1925, *J. Ind. Inst. Sci.*, 143; (6) Sanjiv Rao, Shintre, and Simonsen, 1928, *J. Ind. Inst. Sci.*, 187.

CUSCUTA REFLEXA Roxb. (Convolvulaceæ)

VERN.—Arab.—*Kashus*, *Sharulzabiha*; Assam.—*Amarlati*; Beng.—*Algusi*, *Hadialgusilutta*; Eng.—*Dodder*; Hind.—*Akashabela*, *Amarabela*; Mar.—*Amarvela*, *Nirmulia-kashavela*; Pers.—*Aftimoon*, *Belparash*; Punj.—*Amil*, *Nilathari*, *Niradhar*, *Zarbuti*; Sans.—*Akashabhavana*, *Amaravallari*, *Nilatar*, *Vyomavallika*; Tam.—*Kodiyagundal*, *Sadadari*; Urdu.—*Akashabel*, *Imalbel*.

This is an extensive parasitic climber which makes the tree upon which it grows bend with its weight. It often grows to such an extent as to completely cover every bough and leaf. It occurs throughout the plains of India and ascends to an altitude of about 5,000 ft. in the Himalayas. In the Ayurvedic medicine, the plant is considered to be acrid, bitter and astringent to the bowels. It is said to be useful in the diseases of the eye and of the heart. In the Mohammedan medicine, the herb on account of its bitter sharp taste, is considered carminative, anthelmintic, purgative, diuretic, purifier of the blood and cleanser of the body. It is also useful in jaundice, joint pains, paralysis and vomiting. The seeds are regarded as carminative and for this purpose are boiled and applied over the stomach. According to Carter an infusion made from the plant is used to wash sores in Lakhimpur.

CHEMICAL EXAMINATION.—Dymock separated from the seeds of the plant a bitter substance, a glycosidal resin and quercetin. An alkaloidal principle was also present which failed to give the usual colour reactions. Aggarwal and Dutt (1935) made a systematic examination of this plant and isolated 0.2 per cent. of cuscutin, a colouring matter in a crystalline form along with a white crystalline substance (1.0 per cent.) having the properties of a lactone which they named cuscutalin. A small amount of brown wax (0.1 per cent.) and large quantities of reducing sugars were also isolated. The colouring matter cuscutin is feebly acidic in nature and dissolves in sodium bicarbonate. Cuscutalin is a lactone (m.p. 68°C.) which crystallises in colourless flakes from alcohol. It has formula, $C_{18}H_{16}O_4$. The seeds contain a fixed oil (3 per cent.), a colouring matter amarbelin (0.1 per cent.), an amorphous bitter resin (1.0 per cent.) and reducing sugars. The oil mainly consists of linolinic acid (9.92 per cent.), linolic acid (17.26 per cent.), oleic acid (25.58 per cent.), stearic acid (27.2 per cent.), palmitic acid (11.5 per cent.) and unsaponifiable matter (1.8 per cent.). A phytosterol (m.p. 134-35°C.) has been isolated from the unsaponifiable matter (1.80 per cent.). Amarbelin $C_{18}H_{16}O_7 \cdot H_2O$ m.p. 234°C is a colouring matter belonging to the flavone group. It is obtained from hot water as soft yellow tufts.

No pharmacological work has been done so far and no clinical trials have been carried out.

References:—

(1) Aggarwal, R. and Dutt, S., 1935, *Jour. Ind. Chem. Soc.*, 384 586; (2) *Ibid*, 1936 284, 531.

DAEMIA EXTENSA R. Br. (Asclepiadaceæ)

VERN.—Beng.—*Chagulbanti*; Bomb.—*Utarni*; Hind.—*Sagowani*, *Utran*, *Jutuk*; Guj.—*Nagala dudhi*; Mal.—*Velip-paritti*; Punj.—*Uttururi*, *Uriya*, *Karial*, *Siali*, *Trotu*; Mar.—*Utarana*; Sans.—*Yugaphala*; Tam.—*Utarni*, *Velip-parutti*, *Uttamani*.

This is a perennial twining herb which grows throughout the hotter parts of India often at an altitude of 3,000 ft. above the sea level. It yields, when bruised, a copious milky juice with a foetid odour. A variety of medicinal properties are attributed to it in Indigenous medicine. It is said to be pungent, cooling, anthelmintic, laxative, antiperiodic, useful in eye troubles, urinary discharges, leucoderma, uterine complaints, strangury and inflammatory conditions. It is believed to facilitate parturition. The juice of the leaves is used as an expectorant in catarrhal affections of the lungs. It is given internally in asthma and is applied locally to rheumatic swellings. In combination with lime or ginger it is given internally in amenorrhea and dysmenorrhea.

CHEMICAL COMPOSITION.—Dymock in *Pharmacographia Indica* mentions the presence of an alkaloid which he designated as duemine. Hartwich (1897) referred to the presence of a glycoside in the plant but gave no details of its properties or pharmacological action. Dutta and Ghosh (1947) investigated the whole plant and isolated a number of sterols, three of which were obtained in a pure state and the fourth in fairly pure state. No substance of alkaloidal nature as reported previously was obtained but about 2.4 per cent. of inorganic salts consisting mainly of potassium nitrate and potassium chloride were isolated. Besides these there is a bitter resin and three bitter substances, one of which is glycosidic in nature. Sterol A occurs in white silky needles m.p. 172-6°C.; sterol B occurs in white silky needles, m.p. 163°C.; sterol C in white needles, m.p. 157°C.; sterol D is a soft yellow mass, m.p. 76-80°C. None of the bitter principles isolated could be obtained in the pure state. The bitter principle C which is glycosidic in nature is soluble in water, the other two being only partially soluble. They occur as a deep brown glassy mass which is very hygroscopic.

PHARMACOLOGICAL ACTION.—The bitter principle A was found to be practically inactive. Bitter principle B was found to be somewhat toxic and bitter principle C was found to be most active pharmacologically. It is toxic to white mice, frogs, guinea-pigs and cats. The lethal dose for white mice by intravenous injection is of the order of 12.5 mg. per kilo body weight.

Action on the Uterus.—The action of *Daemia extensa* on the uterus appears to be of special interest in as much as in the intensity of the contraction produced by it compares favourably with pituitrin. The increased tone is, however, sustained at a lower level. Whereas pituitrin acts with equal intensity on both the upper and lower uterine segments, *Daemia* produces earlier and well marked contraction in the upper uterine segment. As this is in many ways similar to the contractile processes initiated in the course of normal labour, its use in the first stage of labour may be rational. Unlike pituitary extract, progesterone does not appear to inhibit the action of *Daemia* on the uterus. Clinical trials with *Daemia* in labour have not so far been reported but would be of great interest.

Action on the Intestines.—*Daemia* exerts a stimulating effect on the smooth muscle of the intestines, similar to that of pituitrin. Such action is particularly

marked in the atonic intestines of paralytic ileus. The gastric secretions are stimulated resulting an increase in total acidity of the gastric juice particularly after a milk feed.

Action on Other Smooth Muscle.—Administration of Daemia extracts appear to cause a generalised stimulation of involuntary muscles, plain or striated. Thus there is a pronounced effect on the circulatory system, raising the arterial blood pressure appreciably. The tone and movements of the urinary bladder are increased. This stimulant action of Daemia appears to be due to (1) partly direct stimulation of the involuntary muscles and (2) partly to the stimulation of the post-ganglionic cholinergic nerves in the structure concerned. On account of these remarkable properties further studies with regards to its action and therapeutic uses is indicated.

References:—

(1) Dymock, Warden and Hooper, 1891, *Pharmacographia Indica*, II, 442; (2) Hartwich, *Neue Arsenidrogen*, 1897; (3) Gupta, J. C., Roy, P. K., and Dutta, A. T., 1946, *Ind. Jour. Med. Res.*, 181; (4) Dutta, A. T., and Ghosh, S., 1947, *J. Amer. Pharm. Assn.*, 250; (5) Gupta, J. C., Roy, P. K., Roy, G. K., and Dutt, A., 1950, *Ind. Jour. Med. Res.* 75.

DICHROA FEBRIFUGA Lour. (Saxifragaceæ)

VERN.—Hind.—*Basak*; Nepal.—*Asclu*, *Bansuk*, *Basak*.

This is a handsome evergreen shrub 5 to 9 ft. high with opposite lanceolate leaves, bluish flowers and bright dark blue berries. It is gregarious in habit and occurs abundantly in the temperate Himalayas from Bhutan to Nepal and Khasia hills at altitudes of 4,000 to 8,000 ft. above sea level. It is also found in Upper Burmah, Malayan peninsula and China. The drug is collected mostly from wild plants and in recent years cultivation of it has been undertaken in China extensively. The plant thrives well in fertile loam soils in mountain valleys and under humid warm climates with temperature ranging from 60-80°F. It is best propagated from cuttings of young branches planted early in spring in covered and sheltered nurseries and then transplanted in the fields. Cuttings may also be planted directly in fields in which castor plants are grown for shelter. The plants are dug up after 3-4 years in fine weather in February or August. The roots are separated from the shoots, washed and dried in sun. The dried roots with small portions of the stems attached are known in China as Chang Shan, the dried leaf tops also used as a drug are called Shu Chi. Both are used in China along with betel nut, turtle shell and ginger in the treatment of malaria. In India too the plant is a household remedy, the roots and tops being used as a febrifuge in regions in which it occurs, particularly in Nepal.

CHEMICAL COMPOSITION.—The plant was examined by Hartwich (1897) who isolated a glycoside dichroine from it. Investigations on the plant as a possible source of an antimalarial remedy was undertaken during World War II when due to shortage of quinine, interest in possible substitutes was stimulated. Jang and co-workers (1946) isolated from the roots of the plant five alkaloids α -dichroine (m.p. 136°C.), β -dichroine, (m.p. 146°C.), γ -dichroine (m.p. 161°C.), dichroinine, $C_{18}H_{25}O_3N_3$ (m.p. 213°C.) and 4-ketodihydroquinazoline

$C_8H_8ON_2$, (m.p. $212^\circ C.$). The three dichroines ($C_{16}H_{21}O_3N_3$) are isomeric and get mutually converted into each other under certain conditions. Kuehi (1948) isolated from the roots of the plant 2 isomeric alkaloids ($C_{16}H_{19}O_3N_3$), alkaloid I (m.p. $131-32^\circ C.$), and alkaloid II (m.p. $140-42^\circ C.$). Alkaloid I was unstable under certain conditions and gets converted into alkaloid II. Both alkaloids have almost identical ultra-violet and infra-red spectra. Besides the alkaloidal constituents, Jang isolated from the roots and leaves of the plant, two neutral principles, umbelliferone (dichrin A, m.p. $228-30^\circ C.$) and dichrin B, m.p. $179-81^\circ C.$ The roots and leaves were examined by Koepfli (1949) who showed that they contain two inter-convertible isomeric, crystalline and optically active alkaloids, febrifugine ($C_{16}H_{19}O_3N_3$, m.p. $139-140^\circ C.$) and isofebrifugine. A crude base occasionally encountered during the isolation studies and melting at $150^\circ C.$ was thought to be a third alkaloid but was later shown to be a dimorphic form of febrifugine. Both alkaloids gave identical ultra-violet absorption spectra. Further these workers reported that despite some disagreement in the melting points, α -dichroine corresponds to isofebrifugine and Alkaloid I, and that β -dichroine and α -dichroine are not two different isomeric, alkaloids, but are the two crystalline modifications of febrifugine. Alkaloid II may correspond to one of these forms. The alkaloids are all stable and it is possible some are formed during the process of extraction. The root material from China yielded 0.08-0.1 per cent. of crude alkaloids of which 55 per cent. consisted of febrifugine and isofebrifugine. The ratio of febrifugine and isofebrifugine varied from 6 : 1 to 1 : 1. The crude alkaloid content of the root specimens collected from India 0.05 per cent. of which 63 per cent. was febrifugine and 2 per cent. isofebrifugine. The leaves of the Indian plant contained 0.01-0.02 per cent. of crude total alkaloids of which 50 per cent. was febrifugine.

PHARMACOLOGICAL ACTION.—Jang and co-workers (1946) tested this drug clinically. They administered an extract equivalent to 7.5-15 gm. of the crude drug to 13 patients with tertian malaria two or three times a day. The treatment was continued for an average of 5 days along with 152 cases treated with quinine as controls. It was observed that this drug had an antipyretic effect equivalent to quinine but its antiparasitic action was not so marked. The action of the drug on chicks infected with *Plasmodium gallinaceum*, demonstrated its effectiveness in lengthening survival period but not in preventing relapses. Acute toxicity tests gave the following approximate LD 50 values, 20 g./kg. body weight (dogs) 22 g./kg. (ducklings) and 14 g./kg. (chicks). Jang in 1949 further showed that the activity of the bases against *P. gallinaceum* infection in chicks is in the following descending orders. δ -dichroine, β -dichroine, dichroidine and quinazolone. The antimalarial potencies of α , β and δ -dichroines against *P. gallinaceum* in chicks are roughly 1.50 times that of quinine, their toxicities are in the same order. Nausea and vomiting are the common toxic reactions observed.

Further work on this plant by Indian workers may prove beneficial. Besides their antimalarial activity the property of these alkaloids in other respects may be worth investigating.

References:—

- (1) Hartwich, C., *Neue Arsenidrogen*, 1, 27; (2) Jang. Fu. Wang. Huang. Lu, and Chou, 1946, *Science*, 103, 59; (3) Jang. Fu. Huang. and Wang, 1948, *Nature*, 161, 400; (4) Koepfli, Mead and Brockman, 1947, *J. Amer. Chem. Soc.*, 69, 1837; (5) Koepfli, Mead and Brockman, 1949, *J. Amer. Chem. Soc.*, 1048; (6) Jang. Huang. Wang., 1949, *Chem. Abs.*, 1529.

DIDYMOCARPUS PEDICELLATA R. Br. (Gesneriaceæ)

VERN.—Hind.—*Pathar phori*; Sans.—*Shila pushpa*.

It is a small herbaceous plant found in the sub-tropical western Himalayan region from Chamba to Kumaon, at altitudes of between 2,500 and 5,500 ft. above sea level. The stem is nearly absent, sometimes upto $1\frac{1}{2}$ in. long, and carries two or three pairs of opposite glabrous, cauline leaves. The dry leaves possess a characteristic spicy odour and appear dusted with reddish colouring matter. They have the reputation in indigenous medicine as a cure for stones in the kidney and bladder which it is believed are dissolved and passed out in urine. The herb however, is not mentioned in Dymock's Pharmacographia Indica or Wehmer's Pflanzenstoffe (Ed. 1930).

CHEMICAL COMPOSITION.—Siddiqui (1937) examined the plant and isolated and characterised the following well defined crystalline products:

(1) Pedicin, $C_{18}H_{18}O_6$, m.p. $145^{\circ}C.$, bright orange red elongated rectangular plates (yield 1 per cent.).

(2) Isopedicin, $C_{18}H_{18}O_6$, m.p. $105^{\circ}C.$, star-like aggregates of pale yellow prismatic rods and needles (yield 0.4 per cent.).

(3) Pedicinin, $C_{16}H_{12}O_6$, m.p. $203^{\circ}C.$, carmine red aggregates of stout rods and needles (yield 0.3 per cent.).

(4) Pedicellin, $C_{20}H_{22}O_6$, m.p. $98^{\circ}C.$, aggregates of colourless rectangular plates (yield 1 per cent.).

Storage of the drug for long periods was found to materially lower the yields of all the crystalline products. Apart from the products isolated above, an essential oil was also separated (yield 1.8 per cent.).

This plant is only used as a household remedy in the areas in which it grows. Further pharmacological and clinical studies may throw more light on its utility in renal and bladder calculi.

Reference:—

(1) Siddiqui, S., 1937, *Jour. Ind. Chem. Soc.*, 703.

DREGA VOLUBILIS Benth. ex Hook. (Asclepiadaceæ)

VERN.—Beng.—*Titakunga*; Bomb.—*Dodhi*; Hind.—*Nakchhikni*; Mal.—*Vattakkakkakkoti*; Sans.—*Hemajivanti*, *Hemakshiri*, *Hemapurna*, *Hemavalli*, *Hemavha*, *Madhumalati*, *Suparnika*, *Svarnajiva*, *Svarnalata*, *Trinagranthi*; Tam.—*Kamal*, *Kodippalai*, *Kudasapalai*, *Kurinja*, *Singittam*, *Sivandi*, *Vanadittam*; Tel.—*Dudipala*, *Palakura*, *Palatige*.

This is a stout tall climbing shrub which grows wild in Assam, Bengal, the Deccan peninsula from Kankaya southward to Ceylon. In the Ayurvedic medicine the plant has been described as cure for tumours, piles, leucoderma, asthma and urinary discharges. It is said to have a laxative antipyretic effect and is believed to have aphrodisiac properties. It is also considered to be useful in the treatment of dyspepsia, inflammations, biliousness and diseases of the eye. The

roots and tender stalks are considered to be emetic and expectorant; the leaves are largely employed as external application to boils and abscesses.

CHEMICAL COMPOSITION.—Hooper (1891) mentions the presence of an alkaloid and glycoside in the plant but no subsequent reference has been found in the literature, till recently when Gupta and co-workers (1951) isolated a substance of glycosidic nature from the plant. They also confirmed the presence of traces of a substance of alkaloidal nature in the roots. The chemical properties of neither the glycoside nor of the alkaloid were, however, studied.

PHARMACOLOGICAL ACTION.—The glycoside was found to exhibit low toxicity in mice and frogs. It stimulates all organs having cholinergic nerve supply and this stimulation is antagonised by atropine. The drug produces a short initial rise of blood pressure followed by a subsequent and prolonged fall. The initial rise persists after atropine and appears to be due to initial stimulation of the heart. The fall of blood pressure is seen in both pithed and unpithed cats and is due apparently to stimulation of the cholinergic nerve endings.

No work to substantiate its alleged therapeutic efficacy has been carried out.

References:—

(1) Hooper, D., 1891, *Pharm. Jour.*, 617; (2) Gupta, J. C., Roy, P. U., Dutta, A. T., and Roy, G. U., 1951, *Ind. Jour. Med. Res.*, 255.

ENTADA PURSAETHA DC. (Leguminosæ)

Syn. *Entada scandens* Benth.

VERN.—Hind.—*Chian, Gila*; Beng.—*Gilagach*; Assam.—*Gila-lewa*; Bomb.—*Gardal*; Tam.—*Chillu, Sillu*; Tel.—*Gilatige*.

It is a leguminous climbing shrub which grows in the central and the eastern Himalayas at altitudes of 4,000 ft. above sea level. It is also found in the damp forests of Eastern Bengal, Bihar and Orissa, in the forest regions of the Eastern and Western Ghats, and in the hilly forest tracts of the northern districts of Bengal and the Deccan. The pods of this plant are several feet long and about 3 to 5 in. wide. The seeds, largely employed for crimping linen in Bengal and in the Uttar Pradesh are about 3 to 4 centimeters in diameter and discoid in shape. The outer covering of the seed, about 1/16 of an inch thick, is tough, horny, chestnut coloured and shining in appearance. The white kernels of the seeds are eaten by poor people who first soak them in water and subsequently roast them. If taken otherwise, these seeds produce toxic symptoms such as vomiting and drowsiness. Mentions has also been made with regard to its medicinal properties as a household remedy. Some hill tribes of India use the seeds in the same way as soap to wash their hair. A paste prepared from the seeds is applied locally to inflammatory swelling of the glands. A poultice made from the kernel applied locally, is believed to relieve colicky abdominal pains. The seeds are also used as a fish poison in certain parts of India, in South Africa and in the Phillipine Islands.

CHEMICAL COMPOSITION.—Rosenthaler (1903) isolated two saponins, Entado saponin A and B with molecular formula, $C_{15}H_{22}O_{10}$. Besides these, 8 per cent. of a fixed oil was

extracted from the kernels of the seeds. Bacon (1906) obtained 7 to 10 per cent. of saponin as white amorphous powder from the bark. Bacon and Marshall (1906) found this saponin to be highly toxic to rabbits and guinea-pigs and also observed its powerful haemolytic properties. The saponin kills amoeba and some flagellates found in tap-water and in the water of stagnant ponds. It was noted, however, that air bacteria grow abundantly in a solution of the crude saponin. In many of their chemical properties the two saponins are identical. Both of them are white amorphous substances with a sharp taste, slightly acid to litmus, soluble in water and alcohol but insoluble in ether, chloroform, benzene and petroleum ether. They are precipitated by basic lead acetate. With concentrated sulphuric acid, they give brown coloration and with dilute hydrochloric acid they undergo hydrolysis.

PHARMACOLOGICAL ACTION.—Both the saponins isolated from *E. pursaetha* have identical actions and are almost equally toxic. The saponins are much less toxic to paramaecia and non-toxic to mosquito larvae. The main action is upon the haemopoietic system where they cause haemolysis of the red blood cells. A sharp fall of blood pressure was observed in experimental animals after doses of saponins, varying from 0.0005 to 0.002 gm. per kilo body weight. The fall was associated with an increase in the volume of the intestines, and to a lesser extent of the kidneys. The fall of blood pressure may partly be the result of the dilatation of the vessels of the splanchnic area and partly due to the depressant effects on the myocardium of the heart. The fall in blood pressure was absent in atropinised animals. The saponins have depressant effects upon the respiratory system and death appears to result from respiratory failure. They have also inhibitory effects on the movements of unstriated muscles of the intestines and the uterus.

No proper clinical trials have been carried out.

References:—

- (1) Bacon, 1906, *Philippine J. Sci.*, 1021; (2) Bacon and Marshall, 1906, *ibid*, 1037; (3) Rosenthaler, 1903, *Arch. Pharm. Berl.*, 241, 614; (4) Chopra, R. N., Gupta, J. C., Chopra, G. S. and Ghosh, B. N., 1940, *Ind. Jour. Med. Res.*, 469.

EUPHORBIA PILULIFERA Linn. (Euphorbiaceæ)

VERN.—Hind.—*Dudhi*; Beng.—*Bura keru*; Tam.—*Amu-patchay-arissi*; Tel.—*Nanabecam*; Guj.—*Dudli*.

E. pilulifera is an annual herb which occurs throughout the hotter parts of India. In the indigenous system of medicine, it has a great reputation and is believed to be a sovereign remedy for diseases of the respiratory tract in general, especially cough, coryza, bronchitis, asthma, etc. Many years ago it attracted the attention of the Western physicians who came to India and it was through their influence that the drug was introduced into Europe somewhere about 1884. The alcoholic extract of the whole plant is used in medicine even to this day though not to the same extent as before. It is also claimed to be a useful remedy in dysentery and colic and has been largely used against worms in children.

CHEMICAL COMPOSITION.—Hooper investigated the chemical composition of the drug long ago but could not find any active principle to which the specific properties of the drug could be ascribed. Later, the chemistry of the drug was worked out more thoroughly and gallic

acid, quercetin, a new phenolic substance, traces of an essential oil, traces of an alkaloid, etc., have been isolated.

PHARMACOLOGICAL ACTION.—Marsset (1928) studied the pharmacological action of euphorbia extract and found that it had a depressant action on the heart and respiration and produced a relaxation of the bronchioles by its central action. Dikshit and Kameswar Rao (unpublished) (1931) investigated the action of this drug. They find that the liquid extract of euphorbia (P.D. & Co.) is irritant to the mucous membrane of the stomach, a dose of 2 c.c. of the extract producing vomiting in animals. Intravenous injections do not produce any vomiting showing that the drug is a true local irritant. In animals under urethane anaesthesia, intravenous injections of small doses of euphorbia extract produce bronchodilation which is much more prolonged than that produced by small doses of epinephrine. The extract has also been found to have a depressant action on the cardiovascular system in general; the musculature of the heart is slightly depressed.

THERAPEUTIC USES.—Euphorbia has been used in Western medicine for a fairly long time but the clinical results obtained do not show that it is likely to be a promising drug. Its pharmacological action so far investigated indicates that its use in spasmodic conditions of the respiratory tract at least is rational. The drug is often used indiscriminately in all sorts of respiratory diseases and hence the desired effects of the drug are often not manifested. This probably explains the many conflicting reports recorded as to the efficacy of the drug. It appears to have no advantage over many of the well-known remedies used in respiratory affections.

References :—

(1) Marsset, 1928, quoted by Solis-Giethen's *Pharmacotherapeutics*, published by Appleton & Co., 1931.

GYMNEMA SYLVESTRE R.Br. (Asclepiadaceæ)

VERN.—Arab.—*Barkista*; Beng.—*Gadalshingi, Medashinge, Meshasingi*; Bomb.—*Kavali, Wakandi*; Eng.—*Periploca of the woods, Small Indian Ipecacuanha*; Hind.—*Chhotadudhilata, Gurmar, Medhashingi, Meshasingi*; Pers.—*Kakar singi, Kakra singi, Kista*; Sans.—*Ajaballi, Ajaghandini, Ajashrangi, Karnika, Mesharingi, Nandivruksha, Vrikshikali*; Tam.—*Adigam, Ayagam, Kogilam, Shirukurinja*; Tel.—*Podapatri, Putlapodra*; Urdu.—*Kakar singi, Kakra singi, Mendha singi*.

G. sylvestre is a stout, large, woody, climbing plant which grows abundantly in central and southern India and is also distributed to Tropical Africa. The plant has been described in the Hindu *Materia Medica* as an anti-periodic, stomachic, and diuretic. Susruta describes it as a destroyer of 'madhumeha' (glycosuria) and other urinary disorders. About a hundred years ago, Edgeworth noticed that when leaves of this plant were chewed, the power of the tongue to appreciate the taste of sugar and all saccharine substances was abolished. This was confirmed later by Hooper who discovered that the leaf also had the valuable property of completely removing the taste of bitter articles such as quinine. The loss of

these sensations lasts only for one to two hours and not for 24 hours as was stated by Edgeworth. The root of the plant has a reputation among the Hindu physicians as a remedy for snake-bite. The powdered root is generally applied locally to the part bitten and a decoction is administered internally.

On account of its property of abolishing the taste of sugar it has been given the name of 'gur-mar' meaning 'sugar destroying' and the idea has gained ground in some quarters that it might neutralise the excess of sugar present in the body in diabetes mellitus. In Bombay and central India it has been used as a remedy against this condition and wonderful results have been claimed.

CHEMICAL COMPOSITION.—Hooper (1887) made the first systematic examination of the leaves. He isolated two resins, the resin insoluble in alcohol forming the larger proportion. The resin soluble in alcohol was said to leave a tingling sensation in the throat. There was no tannin. He had also isolated an organic acid said to be a glycoside and to possess anti-saccharine property. It was designated as *gymnemic acid* and the formula $C_{32}H_{55}O_{12}$ was given to it. It was present to the extent of 6 per cent. A new bitter principle, some tartaric acid and calcium oxalate were also isolated. Power and Tutin (1904) next took up the subject and made a thorough investigation of the leaves. They isolated hentriacontane $C_{31}H_{64}$, quercitol and gymnemic acid. The gymnemic acid was purified and analysed; they showed that it did not possess any anti-saccharine properties and was not a glycoside. Chopra, Bose and Chatterjee (1928) prepared different fractions from the leaves, isolated the gymnemic acid and prepared a sodium salt of the acid for both pharmacological and clinical trials. They also isolated some enzymes and tested their sugar-hydrolysing action. Recently, Mhaskar and Caius (1930) have made a detailed chemical investigation of the leaves of *G. sylvestre*. The air-dried leaves yielded, after ignition, 11.45 per cent. of inorganic matter consisting of alkali, phosphoric acid, ferric oxide and manganese. Two hydrocarbons, hentriacontane and pentatriacontane, chlorophyll a and b, phytol, resins, tartaric acid, inositol, anthraquinone bodies and gymnemic acid were also identified. They could not find any water-soluble or alcohol-soluble substance in the leaves which had the property of dissolving glucose *in vitro*, nor any chemical body resembling insulin.

PHARMACOLOGICAL ACTION.—The action of the enzymes isolated from *G. sylvestre* was studied *in vitro* on both cane sugar and glucose. The sugar solutions were made up to a definite strength and then mixed with the powdered leaves of the plant and also with the enzyme isolated from the leaves. The mixtures were kept in an incubator at 37°C for 48 hrs. and estimations were made at regular intervals to see if any changes occurred. The following results were obtained:

- (a) The reducing substance present in the leaves was found to be 0.337 per cent.
- (b) In the cane sugar solution mixed with the powdered leaves, hydrolytic action commenced within 2 hours and was completed in 18 hours. The same result was obtained in the cane sugar solution mixed with enzyme isolated from the leaves.
- (c) The powdered leaves of *G. sylvestre* were found to have an oxidase action on glucose solution and glycolysis occurred which reduced the strength of the glucose solution from 2.3 to 0.66 per cent. in 29 hrs. In the enzyme isolated from the leaves no such action was seen.
- (d) The gymnemic acid was found to have neither hydrolytic nor oxidase action when mixed with cane sugar or glucose solution.

The effect of the drug on the blood sugar was tested on rabbits. The animals used were carefully selected, were all over 1.0 kg. in weight, and were of the albino Himalayan and the brown Belgian hare types. A quantitative estimation of the initial blood sugar was made

and then the drug was given by subcutaneous injection. Two hours after injection the blood sugar was re-examined. Besides pure gymnemic acid, the following fractions were tried and the effect on the blood sugar in animals were recorded: (1) an aqueous extract of the powdered leaves; (2) an alcoholic extract using 95 per cent. alcohol; (3) an alcoholic extract using 70 per cent. alcohol; (4) sodium salt of gymnemic acid. In none of the animals to whom these fractions were given was there any reduction in the amount of sugar present in the blood. It may be argued that the non-reduction of blood sugar in these rabbits after injection of the various preparations of *G. sylvestre* might be due to the excess of glycogen in the liver of these rabbits, which by being converted into sugar tends to prevent the fall in blood sugar. This may of course be possible in a well-fed animal but to obviate this fallacy the experimental animals were carefully starved from 24 to 36 hours before the test. According to Mhaskar and Caius (1930), however, the leaves cause hypoglycaemia in experimental animals which sets in soon after the administration either by mouth or by injection. This hypoglycaemia has been explained on the assumption that the drug acts indirectly through stimulation of insulin secretion of the pancreas as it has no direct action on the carbo-hydrate metabolism. These workers are also of opinion that the leaves stimulate the heart and circulatory system, increase urine secretion and activate the uterus.

THERAPEUTIC USES.—The drug was tried in a number of cases of diabetes mellitus in order to see if it produced any reduction in the amount of sugar present in the blood or urine. All the patients were uncomplicated cases of diabetes and were kept in hospital under strict observation. They were all placed on a fixed diet which was strictly under control. The total quantity of urine passed in 24 hours was carefully collected, measured and a portion of it was examined every day for the quantity of sugar present. The sugar content of the blood was also estimated from time to time, the 'fasting level' of blood sugar being always recorded. The patients were regularly weighed during the course of treatment.

Of the 6 cases treated, 4 were given finely powdered leaves of *G. sylvestre* in doses of one drachm of the powder three times a day. The total intake per day was thus 12 gm. or 180 gr. of the powdered leaves. The drug produced no appreciable effect in reducing either the blood sugar or the total daily output of the urinary sugar. The total excretion of sugar became slightly less in some cases towards the end of the treatment, but such variations may be accounted for by the restricted diet alone. The slight variation in the blood sugar may be accounted for in the same way. Administration of insulin to all these cases rendered them sugar free. These findings, however, are not in accord with those of Mhaskar and Caius (1930), who are of opinion that the leaves of *G. sylvestre* in daily doses of 30 to 60 gr. (dry leaf) for a period of three months or more may reduce glycosuria, non-amenable to dietotherapy. It is, however, too early to give any definite opinion and further work is necessary to estimate the real antidiabetic property of the drug.

SUMMARY.—According to the findings of the workers of the School of Tropical Medicine the leaves of *G. sylvestre* contain a substance which has a hydrolytic action on cane sugar. There is also an oxidase-like substance which produces glycolysis in a solution containing glucose. The extracts made from the leaves as well as gymnemic acid and its sodium salts have no effect on the blood sugar when given by subcutaneous injections to rabbits. Powdered leaves

and alcoholic extracts prepared from the leaves of *G. sylvestre* have no effect on the blood or urine sugar of patients suffering from diabetes. According to Mhaskar and Caius, the drug appears to be useful in checking glycosuria, when administered in 2 to 4 gm. dosage. Further work is necessary to find out the real value of the drug in diabetes.

References:—

(1) Power and Tutin, 1904, *Pharm. Jour.*, 234; (2) Chopra, R. N., Bose, J. P. and Chatterjee, N. R., 1928, *Ind. Jour. Med. Res.*, 16, July; (3) Mhaskar and Caius, 1930, *Ind. Med. Res. Memoirs*, March, 1.

HEDYOTIS AURICULARIA Linn. (Rubiaceæ)

VERN.—Beng.—*Muttia-lata*; Nepal.—*Gookce*; Mar.—*Dapoli*, *Gaimaril*; Mal.—*Kudal churiki*; Kan. and Tel.—*Nela-neckkare*; Konkani.—*Bhooya-nankeri*; Sing.—*Gct-kola*; Malay.—*Mariguti*, *Kenika*, *Kerukoh batu*.

This plant grows wild in the wet lands of the Western Ghats, throughout the length of the Indian Peninsula from the Konkan to Cape Comorin, extending to Ceylon. It grows also in other parts of India where the rainfall is heavy, e.g. Nepal, Sikkim, the Khasia Hills, Chittagong and Eastern Bengal. In Sikkim the leaves are boiled with rice and used as a food. Beyond this, its use either as an economic product or as a medicinal plant is not referred to in the literature. It is, however, very largely used as a household remedy in South Kanara for all sorts of bowel complaints including diarrhoea and dysentery.

CHEMICAL COMPOSITION.—A general examination of the plant by Dey (1930) shows that it contains considerable quantities of tannins, some reducing sugars and glycosides, a small quantity of fixed oil, a fruity-smelling ester and a basic principle precipitated by the common alkaloidal reagents. This basic principle is found to occur in all parts of the plant, the roots containing the largest amount. An assay of the alkaloids shows that the leaves and stems contain 0.1 per cent. and the roots 0.3 per cent. approximately. The air-dried powdered roots which are selected for detailed examination, yield to petroleum ether 1.1 per cent., to ether 2.6 per cent., to alcohol 8.9 per cent. and water 7.7 per cent. of the extracts respectively. The alcoholic extract has been found to contain the whole of the alkaloids. One of the alkaloids has been purified and its hydrochloride has been prepared. The hydrochloride dissolves in water and alcohol with a bright bluish green fluorescence.

Dey and co-workers (1933) found that the roots contain an alkaloid heydyotine, $C_{16}H_{22}O_3N_2$. It is a golden yellow base which is stable when suspended in water but changes colour on drying. Ratnagriswaran (1941) on chemical examination of the roots and stems of the plant has shown the presence of the following constituents in the plant: Fatty matter yielding on saponification stearic and linolic acids, a ptyosterol, alizrin, oxalic acid, glucose, a new crystalline alkaloid auricularine, $C_{42}H_{58}ON_5$, m.p. $210^{\circ}C$. and amorphous bases. Auricularine is different from the alkaloid hedyotine isolated previously from the same plant and unlike the later auraculine is a crystalline base with definite chemical characteristics.

PHARMACOLOGICAL ACTION.—No systematic pharmacological study of the alkaloids has been carried out but it has been shown that they are not very toxic.

THERAPEUTIC USES.—Bhandarkar (1929-30) has carried out clinical trials with the drug both in the form of a bolus of fresh green leaves and as a decoction

of the whole plant. He claims very satisfactory results in dysenteries with or without *E. histolytica* in the stools. According to him even cases which proved refractory to emetine injections, stovarsol, bismuth, kurchi, bael, etc., responded to the regular administration of the liquid extract of *H. auricularia* (Hedaurin). As the drug is not toxic, it can be given to small children without harm. Striking results were also obtained in cases of acute and chronic colitis, and in early cholera. The drug was tried during an outbreak of cholera in the Madras Presidency and it is said to have acted almost as a specific. Other observers, however, are inclined to believe that the drug is not so useful in the treatment of amoebic dysentery as it is claimed to be. Dikshit (unpublished) found that claims made for Hedaurin in the treatment of amoebic dysentery cannot be substantiated. He tried the drug in eight cases of amoebic dysentery with little benefit. The entamoebae were found in fairly large numbers in patients who received Hedaurin for more than four days. The drug may be of use in diarrhoea but here the action in all probability is due to the large amount of tannins present.

References:—

(1) Bhandarkar, P. R., 1929, *Ind. Med. Gaz.*, 64, 387; (2) Bhandarkar, P. R., 1930, *Publication, Pharmacol. Res. Inst., Madras*. (3) Dey, B. B., 1930, *Indian Sci. Cong. Abstr., Chem. Sec.*, 24; (4) Ratnagiriswaran, A. N., and Venkatachalam, K. V., 1942, *Ind. Jour. Chem. Soc.*, 389.

HELICTERES ISORA Linn. (Sterculiaceæ)

THE EAST INDIAN SCREW TREE

VERN.—Arab.—*Altwaallatu*; Beng.—*Antamora*, *Atmora*; Bomb.—*Kawun*, *Kevana*, *Kewan*, *Khiran*; C.P.—*Bottuka*; Guj.—*Murdasing*; Hind.—*Bhendu*, *Kapasi*, *Maraphali*, *Marosi*; Mar.—*Kewan*, *Muradsing*; Mal.—*Ishvaramuri*, *Kaivalanara*, *Kaiyuna*, *Valambiri*; Mad.—*Valambiri*; N.W.P.—*Bhendu*, *Marorphali*; Pers.—*Kishtburkisha*, *Pechaka*; Punj.—*Kupasi*, *Marorphali*; Sind.—*Vurkati*; Sans.—*Avartani*, *Mrigashinga*; Urdu.—*Marorphali*.

It is a tall shrub or a small tree resembling the common hazel found throughout central and western India as far west as Jammu, the central Peninsula and Ceylon. It has bright red and showy flowers which appear in the rainy season. The capsule has long been employed medicinally in India and is still one of the commonest bazar drugs in most parts of the country. It is chiefly employed in intestinal complaints, entering into most of the prescriptions in the indigenous systems of medicine for colic, flatulence, diarrhoea, etc. According to Ainslie it is also used by the Hindu physicians as a remedy for offensive sores inside the ear.

CHEMICAL COMPOSITION.—The pods were analysed long ago by Dymock but he was unable to find any active principle. Recently, they were re-analysed by the department of chemistry, Calcutta School of Tropical Medicine. Besides a quantity of demulcent substance and tannins nothing of any note could be detected.

THERAPEUTIC USES.—The pods are used even to this day in some parts of India, specially the Bombay State, in the treatment of chronic dysentery. They are roasted and are mixed with a number of other ingredients. Some of the patients who have tried them bear testimony to the fact that the symptoms are considerably ameliorated. Apart from this, no definite improvement in the microscopic characters of stools could be found. In proved cases of amoebic dysentery, it does not appear to bring about any marked improvement.

HERPESTIS MONNIERA H.B. & K. (Scrophulariaceæ)

VERN.—Bomb.—*Bama*; Beng.—*Adha-birni*, *Dhop-chamni*, *Brihmi-sak*; Hind.—*Barambhi*, *Barahmi*, *Jal-nim*, *Safed chamni*; Sans.—*Brahmi*, *Manduki*; Mal.—*Beami*; Tam.—*Beami*, *Nirpirimic*, *Nir-brami*; Tel.—*Sambrani chettu*.

This is an annual creeping plant, found in moist places near streams or on the border of tanks throughout India. The root as well as the stalks and leaves are used in the Hindu medicine. It is considered to be a nerve tonic, and useful in insanity and epilepsy. It has been frequently mistaken for *Hydrocotyle asiatica* (Umbelliferae) known in the vernacular as 'thol-kuri'; both these plants are known by the name of 'brahmi' in many places.

CHEMICAL COMPOSITION.—Samples of the drug from different sources were analysed by Bose (1931). It was found that all the specimens contained an alkaloid in varying proportions. The alkaloid could be extracted by macerating the drug with ether-chloroform mixture in the cold. In the case of rectified spirit, prolonged maceration was required for complete exhaustion. Only about 0.01 per cent. of the alkaloid could be isolated by treatment with boiling water but when treated with a mixture of glycerol and water, a larger quantity (0.02 per cent.) of the alkaloid could be isolated. Basu (1944) from the whole plant isolated three new bases: B₁ oxalate m.p. 330°C., plantinic chloride m.p. 100-101°C.; B₂ oxalate m.p. 180°C., plantinic chloride m.p. above 300°C., hydrochloride m.p. 96°C.; B₃ plantinic chloride m.p. 204°C. A hitherto undescribed sterol-like body, C₂₆H₄₆O.H₂O, m.p. 76°C. has also been isolated. It was also observed that the fresh samples of the drug do not contain any appreciable quantity of the alkaloids B₂ and B₃, while old samples preserved in the hot climate of Benares predominantly consisted of B₂ and B₃. B₁ and B₂ can be extracted by shaking with immiscible solvents whereas B₃ is a water soluble base. The sterol isolated from the leaves, C₂₆H₄₆O.H₂O, is saturated but gives all the colour reactions of sterols and has no saponification value. It forms a digitonite. Later Basu (1947) isolated the main alkaloid in pure crystalline form and gave the name herpestine to it. It is a diacidic base having the molecular formula, C₃₄H₄₆N₂O₆ and m.p. 116-17°C.

PHARMACOLOGICAL ACTION.—The alkaloid obtained from *H. monniera* for which the name 'brahmine' is suggested, has been studied by Bose and Bose (1931). They find that it is highly toxic. Frogs are killed within 10 minutes with a dose of 0.5 mg. per 100 gm. body weight. Rats and guinea pigs are killed within 24 hours with a dose of 25 mg. per kilo. body weight. A dose of 0.5 mg. per kilo. body weight of cat produces a fall of blood pressure. In smaller doses, however, there is a slight rise of blood pressure due to vaso-constriction and stimulation of the cardiac muscles. The respiration is stimulated in small doses. Plain muscles like that of the small intestines, uterus, etc., are stimulated in dilutions of 1 in 2,00,000 to 1 in 5,00,000. In therapeutic doses, the alkaloid resembles strychnine in action.

THERAPEUTIC USES.—Bose has used powdered dried leaves of the Brahmi plant with very satisfactory results in cases of asthenia, nervous breakdown and other run-down conditions. According to him, the drug has many advantages over strychnine. It is less toxic than strychnine and will not produce the reflex irritation which is often noticed if nux vomica or strychnine is administered for a long time. Furthermore, *H. monnicra* is a direct cardiac tonic whereas strychnine only indirectly stimulates the heart. In view of the above findings, a further trial of the drug seems very desirable. The quantity of the alkaloid, however, appears to be very small in the leaves.

References:—

(1) Bose, K., and Bose, N. K., 1931, *Jour. Ind. Med. Assoc.* 1, October; (2) Basu, N. K., and Walia, J. S., 1944, *Ind. Jour. Pharm.*, 4; (3) Basu, N. K., and Pabrai, P. N., 1947, *Quart. J. Pharm. Pharmacol.*, 137.

HOLARRHENA ANTIDYSENTERICA Wall. (Apocynaceæ)

KURCHI, CONESSI OR TELlicherry BARK

VERN.—Arab.—*Lasanulaasafirulmurr*, *Tivraja*; Assam.—*Dudcory*; Beng.—*Kurchi*, *Titaindarjau*; Bihar.—*Inderjantulkh*, *Indrajab*, *Lisanula-sufir*; Bomb.—*Dolakura*, *Dowla*, *Kura*, *Pandhrakura*; Hind.—*Dhudi*, *Hat*, *Karchi*, *Kari*, *Karra*, *Kaura*, *Kaurcya*, *Karvaindarjau*, *Kora*, *Kura*, *Kuar*; Kash.—*Keor*, *Kewar*, *Kor*; N. W. P.—*Kuar*, *Kuer*, *Kura*, *Moriya*; Pers.—*Indarjavctalkh*, *Tukhmeaharc-talkh*, *Zabaneekunjashetalkh*; Punj.—*Katwar*, *Kewar*, *Kiam*, *Kocva*, *Kogar*, *Kura*; Tam.—*Erukkalamipalai*, *Indrabam*, *Kasappuweopalai*, *Kalingam*; Tel.—*Amkudu*, *Chedukodisc*, *Girimalika*, *Istarakupala*, *Kakakodise*, *Kodaga*.

H. antidysenterica is a small deciduous tree with white flowers. It is a native of the tropical Himalayas, going up to an altitude of 3,500 ft.; it is also found throughout the dry forests of India, even as far south as Travancore. It is also met with abundantly in Assam and in the Uttar Pradesh. The seeds are called 'indrayava' or 'Indra's seeds' in Sanskrit; in Persian it is known as 'indar-jave-talkh' and it is well-known in Arabian medicine.

The plant is fabled to have sprung from the drops of 'amrita' or water of life which fell on the ground from the bodies of Rama's monkeys, which were restored to life by the God Indra. This plant was often confused with another of the same family called *Wrightia tinctoria* which is medically inert. Linnæus was originally responsible for this confusion but it was rectified by Brown (1809), who revised the whole of the Apocynaceæ family. Although differentiation between *H. antidysenterica* and *Wrightia tinctoria* has thus been made for nearly a hundred years, yet they are often mistaken for one another and this fact probably accounts for the drug having fallen into disrepute. *Wrightia tinctoria*, however, has white jasmine-like flowers with a fragrant odour, while the flowers of *Holarrhena* are odourless. Further, the *Wrightia tinctoria* bark can be easily identified from its reddish brown colour and its smooth appearance as compared with the *Holarrhena* bark, which is thicker and is of a dirty white or buff colour and has a markedly bitter taste. The seeds of

Holarrhena resemble oats; they are very bitter and are contained in long follicles about the thickness of a quill. They have a tuft of hairs on the end most remote from the foot-stalk, whilst in the *Wrightia* seeds the tuft is on the end next to the foot-stalk.

A kind of indigo dye is extracted from the leaves, and they are used as fodder in certain parts of the Punjab. The wood is white, soft, and even-grained and is used for carvings and for making furniture. The bark of both the stem and the root and the seeds are amongst the most important of the medicines of the Hindu Materia Medica. The bark is considered to be a powerful antidyenteric, while the seeds are said to have astringent, febrifuge, antidyenteric and anthelmintic properties. In the Arabian medicine the seeds are considered carminative and astringent, valuable in pulmonary affections, tonic, lithotriptic and aphrodisiac. Combined with honey and saffron they are made into pessaries which are supposed to favour conception. The pharmacopoeia of India classed *H. antidyenterica* amongst the non-official remedies but reported very favourably on its therapeutic qualities. The Hindu physicians use it in the form of a fluid extract or expressed juice of the fresh plant, a compound decoction and a confection prepared from the bark and the seeds are often given in dysentery with beneficial results.

CHEMICAL COMPOSITION.—A large volume of chemical work has been done on the bark and seed of *Holarrhena* both in Europe and in India. The European workers have chiefly studied *H. congolensis* while the Indian workers investigated the *H. antidyenterica* grown in India. The total alkaloidal content of the bark has been variously reported by different workers so far as the Indian variety is concerned. Caius and Mhaskar (1927) found only 0.025 per cent. of the alkaloid in the seeds and 0.22 per cent. in the bark. Recent researches by Ghosh and Ghosh (1928) show that the alkaloidal content is much higher and averages about 1.2 per cent. of the total constituents. This is a fairly high figure and shows that it will be quite economical to prepare salts of the alkaloids on a commercial scale.

Haines (1858) first isolated an alkaloid which he named 'conessine' from the commercial name of the bark—'conessi bark'. Ram Chandra Dutt (1881) isolated the total alkaloids which he named 'kurchicine' after the vernacular name of the plant. Warnecke (1886), and Kanga, Aiyar and Simonsen (1925) isolated pure *conessine* from the seeds. Pyman (1919) isolated *conessine* from the bark of *H. congolensis* together with a new alkaloid which he termed *holarrhenine*. Ghosh and Ghosh (1928) have shown that, besides *conessine*, there are two other alkaloids present which have been designed as *kurchicine* and *kurchine* respectively. The alkaloid termed *kurchine* is characterised by having a low melting point 75°C., and it is the most abundant alkaloid present in the bark.

More recently, Ghosh and Bose (1932), working in the School of Tropical Medicine, isolated the alkaloids *kurchine* and *kurchicine* in a pure state. They have made a detailed study of the chemical composition of the free bases and of many of their important salts, *kurchine*, the base which occurs in the largest amount, is shown to have the formula $C_{23}H_{38}N_2$ and *kurchicine* is shown to have the formula $C_{20}H_{36}ON_2$. They are thus different from *conessine* and *holarrhenine* found in African *Holarrhena*.

Howorth (1932) isolated *norconessine* and assigned $C_{23}H_{38}N_2$ formula to it. Siddiqui and Pillay (1932) isolated from the bark three new bases *conessimine*, $C_{23}H_{38}N_2$, m.p. 100°C.; *holarrhine*, $C_{20}H_{38}O_3N_2$, m.p. 240°C.; and *holarrhimine*, $C_{21}H_{36}ON_2$, m.p. 183°C. $C_{20}H_{32}N_2$, and *curchinine*, $C_{21}H_{32}N_2O_2$, not reported before. Siddiqui (1934) isolated further two new alkaloids from the seeds and bark, *conimine*, $C_{22}H_{36}N_2$, m.p. 130°C. and *isoconessimine*, $C_{23}H_{38}N_2$, m.p. 92°C. Peacock and Chowdhury (1935) isolated from the bark a new base *lettocine*, $C_{17}H_{25}O_2N$, m.p. 350–2°C. and from the *latex*, resinols *lettoresinol-A*, $C_{28}H_{50}O_5$, m.p. 227–80°C., *littorisinol-B*, $C_{32}H_{54}(OH)_2$, m.p. 136–37°C. Irani (1946) showed that the alkaloids in *kurchi* seeds are present as glyco-alkaloid which get decomposed during the process of extraction.

KURCHI BISMUTH IODIDE AND ITS PREPARATION.—This is an orange-red powder containing about 27 per cent. total alkaloids and 22.85 per cent. of bismuth. It is sparingly soluble in dilute hydrochloric acid, water and alcohol. (1 gm. base = 3.5 gm. K.B.I. approx.).

The total alkaloids are dissolved in dilute hydrochloric acid and then treated with Dragendorff-Kraut's reagent with constant stirring until there is complete precipitation. The orange-red precipitate is allowed to settle and then filtered and washed thoroughly with distilled water. The precipitate is collected and dried at ordinary temperature.

DRAGENDORFF-KRAUT'S REAGENT.—80 gm. basic bismuth nitrate is dissolved in 200 gm. nitric acid (sp. gr. 1.18) and then poured into a concentrated aqueous solution of 272 gm. potassium iodide and diluted to a litre. (*N.B.*—For K. B. I. we found it better to use the solution diluted to 500 c.c.).

PHARMACOLOGICAL ACTION OF THE ALKALOID.—Kiedel (1878) found that conessine depressed the centres in the brain for conscious sensation and for the initiation of voluntary movements. Burn (1915) stated that conessine and holarrhenine are cardiac poisons as perfusion of the isolated heart with them causes the heart to come to a standstill. Giemsa and Halberkahn, on the other hand, did not find similar effects. It would appear from these that the pharmacological action of the holarrhena alkaloids required further careful study and this was undertaken by the author. The results of this work are briefly summarised below.

CONESSINE: Action on Protozoa.—Brown (1924) appears to have been the first worker to study the amoebicidal properties of conessine. He tested the action of the alkaloid on cultures of pond amoebae and found that it had distinctly lethal effects on this organism. When it was incorporated with the culture medium in strengths of 1 in 10,00,000 it inhibited their growth. Experiments with mice showed conessine to be 50 per cent. less toxic than emetine but its subcutaneous administration in medicinal doses produced local necrosis. On the other hand, he found that it can be safely given by mouth in large doses. Although the alkaloid exerted some toxic action *in vitro* on the bacilli of the dysentery group, it did not appear to produce any effect in bacillary dysentery in man in ordinary therapeutic doses. Henry and Brown (1923) while testing the tannins obtained from the *H. antidysenterica* bark and also those from ipecacuanha against the free-living ciliate protozoon, *Glaucoma*, found both of them to be highly toxic to this ciliate. Chopra and his associates (1927) showed that conessine killed free-living amoebae, proteus and limax, in dilutions of 1 in 2,80,000. Its action on the vegetative forms of *E. histolytica* was tested on the dysenteric stools of experimentally-infected kittens. In mucus flakes in such stools motile amoebae were killed in dilutions of 1 in 2,80,000 in 8 minutes in the presence of an alkali and in 18 minutes in the absence of alkali, as compared with 1 in 2,00,000 of emetine. Conessine produced little effect upon *Trichomonas hominis* but was markedly lethal to the coprozoic flagellate protozoon, *Bodo caudatus*, killing it in dilutions of 1 in 2,80,000 as compared with 1 in 20,000 of emetine.

LOCAL EFFECTS.—Subcutaneous or intramuscular injections of conessine salts are painful and set up a marked oedema and swelling of the area round the site of injections. There are signs of congestion and hyperaemia of the tissues at the site of injection, but no haemorrhage or necrosis of tissues was observed even when a 6 per cent. solution was injected. The effects were visible a few hours after the injection, began to show signs of resolution after 24 hours and disappeared almost entirely after 48 hours.

ALIMENTARY SYSTEM.—Conessine has a bitter taste. When given by the mouth it appears to have a depressing action on the digestive ferments. The action of ptyalin, pepsin and trypsin is inhibited by it. The preparations of *H. antidysenterica* should, therefore, be preferably given two hours after meals so that the digestion is as little interfered with as possible. Intravenous injections of conessine stimulate the peristaltic movements of animal

intestines *in situ*. The tone of the muscle of isolated pieces of gut is increased. This is probably the reason why preparations made from the bark produce looseness of the bowel.

CIRCULATORY SYSTEM.—In large doses, this alkaloid has a depressant action on the auriculo-ventricular bundle in the frog, the heart beats being markedly slowed and there being one beat of the ventricle to 3 to 5 beats of the auricle. Later, the auricles beat quite independently of the ventricles, complete heart block being established. Turtle's heart perfused with conessine showed marked slowing and decrease of amplitude of the beats. In the mammalian heart, small doses produced a temporary increase in both auricular and ventricular contractions, but this was quickly followed by depression. In the cat the heart was visibly slowed after 2 mg. given intravenously. When repeated injections were given the heart became irregular. After large doses a definite heart block is produced, fibrillation and finally stoppage of the ventricles takes place. Isolated mammalian heart is depressed by conessine in such dilutions as 1 in 60,000 to 1,00,000. Conessine appears to act on the fibres of the auriculo-ventricular bundle causing slowing and increase of diastolic pause, arrhythmia and finally heart block. Intravenous injections of conessine invariably produce a marked and persistent fall of blood pressure after a slight momentary rise. With very small doses such as 0.25 to 0.5 mg., there is a tendency to recovery after the fall but with higher doses the fall is more or less persistent, the blood pressure not regaining its normal level for a very long time.

RESPIRATORY SYSTEM.—There is a preliminary stimulation followed by slowing. With large doses, the respirations become slow and shallow and finally stop earlier than the heart.

NERVOUS SYSTEM.—Conessine has a well-marked narcotic action on frogs, 15 mg. injected into the lymph sac of an animal producing paralysis and loss of all reflexes in 10 to 20 minutes. In mammals narcosis is not produced even after large doses. A 5 per cent. solution dropped into the eye of a rabbit produced irritation followed by complete anaesthesia in 6 to 12 minutes.

KURCHICINE.—The alkaloid kurchicine is a general protoplasmic poison like emetine. The M.L.D. in white mice is 38.12 mg., in guinea-pigs it is 64.3 mg. per kilo. body weight. Intravenous injections of the hydrochloride of kurchicine in animals produce a well-marked fall in blood pressure. The heart is depressed but this depression cannot totally account for the fall in blood pressure. With toxic doses there is definite slowing of the heart followed by complete heart block, probably due to the direct depressant action of the alkaloid on the auriculo-ventricular bundle. The alkaloid produces a marked dilatation of the vessels of the splanchnic area. The respiration is at first slightly stimulated, probably secondary to the fall in blood pressure, but with large doses it quickly stops, the heart goes on beating for a long time after. The plain muscles of intestine and uterus are stimulated even in as high a dilution as 1 in 5,00,000.

TOTAL ALKALOIDS.—The action of the total alkaloids has been carefully investigated in view of the powerful action of conessine on the heart muscle. If the action of the total alkaloids on the heart was the same, it would make one hesitate to administer them in large doses. Any limitation of dosage would defeat the end we have in view, *i.e.*, to a concentration of these alkaloids in the large intestine, sufficient to kill the amoebae in spite of the acidity that was present in the gut contents or in the surface tissues.

(a) *Circulation*: Small doses, 2 mg. injected intravenously into the saphenous vein of a cat weighing 2 kilos, caused a persistent fall of blood pressure, but without any alteration in the intensity or frequency of the heart beat. In much larger doses, there was slowing of the heart beat. Perfusion through the isolated heart rarely showed any effect on the frequency or force of the contraction. Doses of 2.5 mg. in a cat of 2 kilos showed no alteration in the auricular and ventricular contraction as seen in myocardiographic tracings. Although there is a marked rise in pulmonary pressure with conessine and holarrhenine, the rise is only slight when the total alkaloids are injected into the animal.

(b) *The Volumes of Various Organs and Structures in the Body:* The limb volume and that of the liver, spleen and kidney were all decreased after intravenous injections of the total alkaloids, indicating that vaso-constriction was occurring at these sites. On the other hand, there was a very marked increase in the intestinal volume with complete inhibition of intestinal movements. From these results it can be reasonably concluded that the fall in blood pressure is due to dilatation of the intestinal vessels and to a lesser extent to engorgement of the lungs.

(c) *Local Effects on Intramuscular or Subcutaneous Injections:* When a 6 per cent. solution was injected into the tissues no haemorrhage or necrosis was observed but a good deal of oedema at the site of the injection. The oedema was most marked after 4 hours and began to disappear after 24 hours and disappeared completely within 48 hours after the injection; hyperaemia and oedema were caused most probably by the acidity of the salt of the alkaloids; 1 to 2 gr. of the salts of the total alkaloids give rise to a certain amount of pain. There were no signs of bruising (haemorrhages) as is seen with emetine nor necrosis as with quinine.

(d) *On the Uterus:* The total alkaloids have very little effect on the excised uterus or on the uterus *in situ* except in strong concentrations which it is impossible to attain in the circulating blood. The alkaloid kurchine with a low melting point is the most powerful, causing contractions in a concentration of 1,50,000. Most alkaloids circulate in the blood at a concentration of 1 in 1,50,000 to 1 in 5,00,000. Therefore, these alkaloids would have little or no effect if given to a pregnant woman.

(e) Even 2 gr. of the total alkaloids repeatedly given intramuscularly do not produce the bodily and mental depressions as are observed with emetine.

From the clinical experiences of nearly two years the following data was gathered regarding these alkaloids. There is no emetic or depressant effect when 20 gr. of the kurchi bismuth iodide are given daily for 10 or even 15 days. The pulse remains normal in frequency, tension and rhythm. There is no alteration in the heart sounds, even in a case of cardiac disease. The drug does not produce irritation of the alimentary canal and diarrhoea as is the case with emetine. If diarrhoea does occur, there is generally a reason such as a co-existing bacillary infection by the *B. dysenteriae* (Flexner or Strong).

THERAPEUTIC USES.—(a) *Bark, Seeds and their Preparations:* The seeds are considered to be serviceable in dysentery, diarrhoea, fevers, flatulence, bilious affections, etc. In the treatment of haemorrhoids they are given in the form of a decoction made with milk and are regarded as most efficacious. 'Indrayava', powdered or infused in warm water, has been found very useful in mild forms of dysentery complicated with worms in children. The bark, however, has enjoyed much more reputation than the seeds. It has often been mentioned in the Hindu medicinal books such as 'Susruta', 'Bhavaprakasa' and the 'Nighantu' and in all these books it has been awarded a very high place amongst the known anti-dysenteric remedies. That it is really a valuable remedy for dysenteric affections has been borne out by the statements of many medical practitioners both Indian and European. As early as 1881 R. C. Dutt recorded clinical cure of several cases of acute and chronic dysentery by the administration of extract made from the bark. Tull Walsh (1891) referred to the use of the bark with satisfactory results. Kanai Lal Dey (1896) was so convinced of its therapeutic value that he advocated its inclusion in the British Pharmacopoeia.

The Indigenous Drugs Committee, seeing the enthusiastic reports given in the Indian Pharmacopoeias, decided to determine the real merits of the kurchi bark in the treatment of dysentery. The procedure adopted by the committee, was to issue standardised drug to hospitals and dispensaries and to collect reports regarding its efficacy in various types of bowel complaints. Report received from time to time were very encouraging and left the impression in the minds of the members of the Committee that the medicine had indeed got some real anti-dysenteric properties. Waring said that it was almost a specific in chronic dysentery and all varieties, whether acute or chronic and whether complicated with fever or uncomplicated, were benefited by it. Koman of Madras reported that in the dysenteries of both children and adults, the liquid extract of kurchi bark gave very satisfactory results in almost every case.

H. antidysenterica has lately been tried somewhat extensively in the treatment of amoebic dysentery. The remedy was at first used in the form of an infusion of the root bark; this, however, is very bitter and most unpalatable. Burroughs Wellcome & Co. have put 'tabloids' made from the bark on the market and in this form it is easily taken and has been combined with emetine treatment with beneficial results. According to Knowles (1928), the simultaneous administration of emetine hypodermically and tabloid of kurchi bark orally is of marked value in the treatment of amoebic dysentery. Caius and Mhaskar (1927) had satisfactory results with powdered whole bark. Knowles and others (1928) tried kurchi orally in 16 patients; 10 patients were put on liquid extract of kurchi and the remaining 6 patients on 'tabloids' of kurchi bark (B. W. & Co.). The ratio of probable cures to failures in his series is surprisingly high for so simple a remedy; the treatment involves no injections and has the additional merit of not developing toxic symptoms. With the 'tabloid' product the dose could be pushed to 60 gr. a day without discomfort. With the liquid extract, 10 dr. a day can be given for 10 days without the patient complaining of any symptoms. In the treatment of acute cases, the improvement was less rapid than emetine but cure appeared to be much more permanent. A standardised extract made from the bark is now on the market, one dr. (4.0 c.c.) containing roughly a gr. of the total alkaloids. The author has used this extract in doses of 2 dr. 3 times a day for 4 to 5 weeks either by itself or in combination with *Plantago ovata* (Ispaghula) in the treatment of very chronic cases of amoebic dysentery with beneficial results. No untoward symptoms or cumulative toxic effects were produced. Even in patients suffering from bacillary dysentery the symptoms are markedly benefited. Besides the antidysenteric properties of Holarrhena, a firm belief exists in the Uttar Pradesh that the bark has very good antimalarial properties. With a view to confirming the truth of the statement large doses of bark extracts as well as of the alkaloids were given to patients suffering from amoebic dysentery who had coexisting malaria; in none of these cases was any effect produced either in the clinical symptoms of the disease or on parasites in the blood.

(b) *The Alkaloids*.—The different active principles obtained from the bark and seeds have been tried from time to time by individual workers in the treatment

of dysentery. Kurchicine has been prescribed both in the form of powder and in solution. The powder was administered in dosage of 2-5 gr. and the solution was prepared by dissolving 2 gr. of the alkaloid in one ounce of water by addition of a little acetic acid. From his experience and that of Coates who treated 7 cases, he declared that kurchicine was a valuable antiperiodic in no way inferior to the cinchona alkaloids.

Conessine has been tried in cases of dysentery by many workers. Willmore (1923) treated 2-3 cases refractory to emetine with injections of conessine without favourable results. Caius and Mhaskar (1927) administered an aqueous solution of conessine hydrochloride (10-20 mg. of alkaloid per ounce) three times a day, the total amount of the drug administered being 30 ounces daily. Ten cases were treated in all, of which 2 were actually cases of amoebiasis. In daily doses of 60 mg. continued for 6 days no toxic symptoms were observed. Six of these cases proved refractory but the amoebic cases did well. Recently, Knowles and his colleagues (1928) tried conessine intramuscularly in 9 cases showing vegetative *E. histolytica* in their stools in the Carmichael Hospital for Tropical Diseases. The stools were examined in most cases for 10 consecutive days after the treatment was over and this was taken as a criterion of cure. The results obtained were not very promising even in cases where the drug was used in 2 gr. doses daily.

Chopra, as the result of his researches from pharmacological point of view, commenced using the total alkaloids of *H. antidysenterica*—'kurchi alkaloids'—in the treatment of acute amoebic infections by intramuscular injections. The results were very gratifying and showed that in acute cases, the total kurchi alkaloids were as powerful as emetine in their immediate effect on the symptoms as well as in their curative value, in such doses as 1 gr. daily. The intramuscular injections produced inflammation and swelling of the parts and were accompanied by considerable pain in some cases. They did not, however, produce any of the general toxic effects usually met with when emetine injections are given, especially for prolonged periods. Some of the patients complained of a momentary sensation of flushing of the face and a feeling of heaviness in the head soon after the injection was given, but these quickly passed off.

Intramuscular injections of the total alkaloids, although they were effective against acute amoebic dysentery, did not produce very satisfactory results in chronic and long-standing cases. It was, therefore, considered advisable to give the alkaloids by mouth in view of the facts that preparations of *H. antidysenterica* bark given by the oral route were much more effective in chronic cases. This led to the preparation of a bismuth iodide compound of the total alkaloids.

KURCHI BISMUTH IODIDE.—Dale and Dobell (1917) first showed the value of emetine bismuth iodide in the treatment of chronic amoebic infections, and got constant curative results by this method of treatment. Their results held good when dealing with young soldiers in England, but the drug was not so successful when dealing with the class of cases met with in India. Knowles (1928) clearly

brought out this point in his paper by the numerous failures he had with all the different combinations of emetine he used in the treatment of these chronic cases.

Acton (1921) first pointed out the importance of the hydrogen-ion concentration (pH) of the solution on the behaviour of *Paramecium caudatum* towards the cinchona alkaloids. He found that both emetine and quinine were ten times more powerful in an alkaline substrate of pH of 8 than in an acid substrate of pH of 6. The stools of patients suffering from acute amoebic dysentery are markedly acid in reaction and the failures in treatment with emetine were considered to be due to the alkaloid not being in sufficient concentration in the acid content of the large gut. The stools in these cases had usually a pH of 5 to 6; this meant that emetine would have to be in a concentration of 1 in 8,000 to 1 in 10,000 to be effective on the amoebae in this substrate. Attempt was therefore made to remedy this acidity of the bowel by giving large doses of bismuth carbonate by the mouth as advocated by Deeks. But this treatment was not successful. According to Acton the high acidity of the stool in dysentery cases is due to mixed infection of the gut. The common organisms met with in the stools of such patients are streptococci, *B. dysenteriae* (Flexner and Strong) and lastly the acid-producing organisms such as *B. lactis aerogenes*, *B. acidi lactici*, etc. A course of autogenous vaccines given to these patients before the emetine bismuth iodide treatment was given greatly increased the cure rates. A combination of vaccine and emetine therapies, however, is not at present very practical in India as the preparation of vaccines requires well-equipped laboratories which are available in large cities only. To obviate this difficulty, a bismuth-iodide compound of kurchi alkaloids was prepared; as the total alkaloids of *H. antidysenterica* were shown to have a powerful action on *E. histolytica* it was thought that such a combination would be a distinct advantage. These alkaloids had no emetic or irritant action on the gut and did not depress the heart. It was, therefore, possible to give them in much larger doses than is feasible with emetine. Moreover, such a compound would remain undissolved till it came to the large intestines. As much larger doses of the total alkaloids in this form could be given, a greater concentration would be obtained in the gut, sufficient to overcome the hindering action of the acidity of the large intestine. Such doses as 10 gr. of the bismuth iodide, containing about 27 to 30 per cent. of the alkaloids, are well tolerated morning and evening for periods ranging from 10 to 20 days. There is no appreciable effect on the pulse rate or blood pressure. There is no alteration in the heart sounds even in organic heart diseases. The depressing, emetic or intestinal irritation that is usually produced by emetine was not observed. No cumulative effects are produced as are observed in the case of emetine. This drug has now been tried on a large series of cases of chronic amoebic dysentery and the results obtained compare very favourably with any of the other drugs used. It is hoped that the advent of these alkaloids will mark a definite advance in the treatment of chronic amoebiasis. The action of the alkaloids in amoebic hepatitis is doubtful. They do not appear to have such beneficial effects in non-suppurative and suppurative hepatitis of amoebic origin as emetine has.

It may be mentioned here that while the total alkaloids and their preparations from some batches of the bark gave remarkable results in clearing up very chronic cases of amoebic dysentery, others proved unsatisfactory. The factors concerned have not been fully worked out and are still under investigation, but it is probable that maturity of the bark or changes in the alkaloids themselves of the nature of racemisation, oxidation, etc., while they are still in the bark may be responsible factors. When these are cleared up and a uniformity of action is obtained, an effective remedy will be found for chronic amoebic dysentery and the demand for the bark will be very large.

SUMMARY.—In the laboratory and clinically the total alkaloids obtained from *H. antidysenterica* bark have a most remarkable action against acute and chronic forms of amoebic infections of the gut. The alkaloids can be given in large doses and without producing depressant, emetic, irritative or cumulative effects. They are much less toxic than emetine. In acute amoebic dysentery intramuscular injections of 1 gr. of total alkaloids produce a cure at least as quickly as emetine. They produce a certain amount of local reaction, pain and swelling which pass off in 24 to 48 hours. In chronic cases 10 gr. of the alkaloids twice daily for 10 days eradicate the infection in a large number of cases. In very persistent cases, a course of 15 to 20 days is given according to the severity of the case. Such prolonged use produces no toxic effects and untoward symptoms. A standardised extract of the bark containing roughly $\frac{1}{2}$ gr. of the alkaloid in 1 dr. (4.0 c.c.) is now on the market. In chronic cases it can be used for 4 to 6 weeks in doses of two dr. three times a day either by itself or in combination with *Plantago ovata* (Ispaghula). A bismuth iodide compound of kurchi alkaloids has also been prepared. This preparation promises to be a valuable treatment for chronic amoebic affections of the bowel particularly in the tropics. As *H. antidysenterica* grows abundantly in the submontane areas all over India from the Himalayas to Travancore it is easily procurable and is cheap. Further the alkaloid content of the bark is high and it is hoped that the advent of this drug marks a definite advance in the treatment of amoebic infections of the bowel in this country.

In spite of the effectiveness of Holarrhena alkaloids it is stated that emetine is not outmoded therapeutic remedy but still holds pride of places in treatment of severe amoebic dysentery, the association of the Holarrhena alkaloids with it offers definite advantage, though these latter do not invariably include the eradication of the amoebic infection.

HOLARRHENA FLORIBUNDA.—Total extract of *H. floribunda* proved effective against trichomonus infestations but had no action on malaria infections or on ascaris, hookworm, strongyloid, giardia or whip-worm infestations.

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HOLARRHENA FEBRIFUGA Klotzsch. (Apocynaceæ)

This is a common shrub found in the coastal districts of Kenya and drier parts of Tanganyika. It also grows abundantly in Northern Rhodesia and Nyasaland and near the Western plains bordering the Lake Nyasa. Its uses appear to have been first recorded by Peter in his *Botanic Von Mosambique*, 1. P. 278 (1862) while its action as a febrifuge is described in Livingstones' *Missionary Travels* p. 468 (1858). In Northern Rhodesia it is known to be used by the natives in the treatment of influenza, bilharzia and syphilis and also as substitute for quinine. Our interest in this plant in India is due to its being an allied species to the well-known drug of indigenous medicine *H. antidysenterica*.

CHEMICAL COMPOSITION.—The plant from Northern Rhodesia was investigated by Siddiqui and co-workers (1944). They found that the concentration of alkaloids is highest in the stem bark (2.4 per cent.), next in the decorticated twigs (0.8 per cent.) and lastly in the leaves (0.12 per cent.). The main alkaloid in the root and stem bark was noted to be conessine, its yield being as high as nearly 60 per cent. of the total alkaloids. From the mother liquors of conessine, it was possible to isolate only one of the subsidiary norbases, which has been identified as isoconessimine, ($C_{23}H_{38}N_2$) isolated earlier by Siddiqui from *H. antidysenterica*. The main difference between *H. febrifuga* and *H. antidysenterica* appears to lie in the fact that the proportion of conessine is much greater in the former than in case of the India *Holarrhena* which contains only 0.1 to 0.4 per cent. of conessine, the rest of the total alkaloid being mainly the subsidiary norbase. It would appear, therefore, that *H. febrifuga* may be a better source for the production of pure conessine, although its total alkaloidal content is definitely lower than that of the Indian species. The fatty matter obtained during the process of the isolation of the alkaloids from the alcoholic extract of the drug was also investigated. The unsaponified fat yielded a non-nitrogenous crystalline product m.p. 68°C. Apart from the saturated fatty acids, palmitic and stearic obtained on saponification of the fat, a sterol which appears to be sistosterol, m.p. 133-134°C. was isolated from the unsaponifiable matter. Lupeol which was isolated in fairly large yields from the Indian *Holarrhena* could not be obtained from *Holarrhena febrifuga*.

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HYDROCOTYLE ASIATICA Linn. (Umbelliferae)

Syn. *Centella asiatica* (Linn.) Urban

VERN.—Arab.—*Artaniyaehindi*, *Jharniba*; Assam.—*Manimuni*; Beng.—*Brahma manduki*, *Tholkuri*; Bomb.—*Karinga*, *Karivana*; Eng.—*Indian pennywort*, *Thick-leaved pennywort*; Guj.—*Barmi*; Hind.—

Brahmamanduki, *Khulakhudi*; Mar.—*Brahmi*; Pers.—*Sardeturkastan*; Sans.—*Bhekaparni*, *Bheki*, *Brahmamanduki*, *Divya*, *Mahaushadhi*, *Mandukaparni*, *Supriya*, *Tvashtri*; Tam.—*Babassa*, *Vallarai*, *Vallari*; Urdu.—*Barhmi*.

This is a small herbaceous plant found throughout India from the Himalayas to Ceylon at altitudes up to 2,000 ft. above the sea level. It is particularly abundant in damp places in Bengal and is a common weed in the vicinity of Calcutta. The plant was known to the Sanskrit writers of very remote times, its properties being similar to those of Brahmi (*Herpestis monniera*). Both plants were regarded as tonic, useful in diseases of the skin, nervous system and blood. In some parts of India people are in the habit of taking the leaves with milk for improving their memory and as an alterative and tonic. The leaves are also said to be useful in the treatment of syphilitic affections of the skin both as an external and internal application. On the Malabar coast the plant is considered as a useful remedy against leprosy. Hunter (1904) after trying it in Madras leper hospital came to the conclusion that it had no claim to consideration as a specific in leprosy but found it very useful in ameliorating the symptoms of this disease and improving the general health of the patient (Watt). The plant, in combination with other drugs, has been recommended as an antidote to snake-bite but Caus and Mhaskar found that no part of it was effective against snake-bite.

CHEMICAL COMPOSITION.—Dymock in *Pharmacographia Indica* reports the presence of an oily substance, a resin, organic acid, tannin and traces of an alkaloid in this plant. Lepin reports the presence of a substance Vallerine (0.8 to 1 per cent.), resin, fat (8.9 per cent.), tannin and sugar (24.5 per cent.), gum and salts (11.5 per cent.), albuminoid matter (12.5 per cent.) and ash (2.4 per cent.). Vallerine has been described as an inspissated oil of a pale yellowish colour with a bitter pungent and persistent taste and with marked odour of the plant. Bose and Bose (1941) investigated the plant but could not find any substance of alkaloidal nature. Wali and Katli (1937) investigated it and obtained from the alcoholic extract an essential oil, oleic, linolic, linolenic, palmitic, stearic and lignoceric acids, sitosterol, tannin, glucose and large amount of a resinous material. Botems (1941) isolated from the fresh leaves a glycoside named asiaticoside consisting of colourless needles, m.p. 232°C. in 0.7 to 1.2 gr. per kilo. yield of the fresh leaves. Basu and Lamsal (1947) isolated from the plant an alkaloid hydrocotyline, $C_{22}H_{32}O_8N$, m.p. 210–12°C.

PHARMACOLOGICAL ACTION.—Hydrocotyle, properly prepared and administered, is a powerful stimulant of the circulatory system, its action chiefly affecting the vessels of the skin and mucous membranes. In larger doses it is a stupefying narcotic, and in some cases produces cephalalgia or vertigo with a tendency to coma. A note in the *British Medical Journal* (1948) states, "we have received through the courtesy of the French Embassy in London a copy of a despatch from Madagascar giving a preliminary account of the discovery of a new remedy which is reported to have given remarkable results in the treatment of advanced lepromatous cases in leprosy. In 1937 Drs. Boiteau and Grimes extracted a new glycoside from an umbelliferous plant growing in Madagascar called *H. asiatica*, which in doses nearing a toxic level gave encouraging results in leprosy. In 1938 Botems, working in the leprosy Laboratory at Antananarivo, discovered a new glycoside, which he called 'asiaticocide' which was much less toxic, but it was insoluble

in water slightly soluble in alcohol, and very soluble in pyridine. By further research Boiteau succeeded in obtaining a solution for injection. Devanne and Razafimahery ascertained the chemical nature of 'asiaticocide'. Boiteau and Grimes are of the opinion that it acts as a solvent of the waxy coating of the bacillus of leprosy, which then becomes very fragile and may easily be destroyed by the tissues or by an adjuvant drug." "The results now reported from clinical trials of the new glycoside include softening, breaking down of nodules followed by cicatrization, testify to its powerful action against leprosy bacillus. Healing of whitlows and perforating ulcers and gradual improvement of anaesthesia and muscular atrophy are also said to occur. Still more remarkable is the claim that eye lesions are rapidly cured if treated before the posterior chamber is involved. It has not yet proved possible to prepare large quantities of the new remedy for extensive trials but in view of the many disappointments during recent years full report of trials already carried out and their confirmation by other workers must be awaited. The most hopeful features of the present account of the work is the success in breaking down leprosy nodules, and still more the clearing up of the hitherto intractable eye lesions." These results should be confirmed by workers in India from the glycoside isolated from the plant of Indian origin.

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HYGROPHILA SPINOSA T. Anders (Acanthaceæ)

Syn. *Asteracantha longifolia* Nees

VERN.—Behar.—*Kantakulika*, *Talmakhana*; Beng.—*Kantakalika*, *Kulaka*, *Kuliakhara*, *Shulamardan*; Bom.—*Kolsunda*, *Talimkhana*; Canarese.—*Kalavankabija*; Ewe.—*Eyitror*; Fanti.—*Atwain*; Guj.—*Ekharo*, *Gokhru*; Hausa.—*Dayingiwa*, *Sareguwa*, *Lagargiwa*; Hind.—*Gokhulakanta*, *Gokshura*, *Kailaya*, *Talmakhana*; Konkani.—*Kolista*; Mal.—*Bahelshulli*, *Vayalchulli*; Mar.—*Talimakhana*, *Vikhara*; Sans.—*Atichhatra*, *Bhikshu*, *Chhatraka*, *Ikshugandha*, *Ikshura*, *Ikshuvalika*, *Kakekshu*, *Kandekshu*, *Kokilaksha*, *Kokilanayana*, *Kshura*, *Kshuraka*, *Kulahaka*, *Pichhila*, *Pikekshana*, *Shrigalaghanti*, *Shrigali*, *Shrinkhali*, *Shiklapushpa*, *Shuraka*, *Trikshura*, *Vajra*, *Vajrakantaka*, *Vajrasthi*, *Virataru*; Santh.—*Gokhulajanum*; Sing.—*Katreiriki*; Tam.—*Neremulli*, *Nirmalli*; Tel.—*Neerugubbi*, *Nirguviveru*; Urdu.—*Talimkhana*; Utkal.—*Kuilirakha*, *Makheruna*.

This annual marshy herb is a member of Acanthaceæ family. The flowers are bright blue and the roots creamy yellow in colour, possessing a peculiar marshy odour and a slimy cooling taste. It occurs commonly in moist places everywhere throughout India from the Himalayas to Ceylon. This herb has

always occupied a prominent place in Hindu Materia Medica. The roots are considered as cooling, diuretic, stimulating and specially efficacious in dropsical conditions and in cases of stone or gravel in the kidney. Mohammedan writers also mention the use of the plant for the same purpose and recommend it as an external application in form of a poultice or as an embrocation in rheumatism. In the 'Pharmacopoeia of India' several European writers bore testimony to the excellent diuretic properties of the roots of this plant.

CHEMICAL COMPOSITION.—The roots of the plant were first examined by Warden (1893) who by extraction with 80 per cent. alcohol isolated a crystalline substance apparently in an impure form which has been described as mass of cauliflower like nodules, nearly white in colour and contaminated with oil. It dissolves in concentrated sulphuric acid with a yellow colour.

Ghatak and Datta (1931) examined the roots and obtained a phytosterol, $C_{28}H_{46}O$, m.p. $194^{\circ}C$. to which the name hygrosterol has been assigned. Besides this the roots yield a trace of essential oil, a yellowish green wax, a sticky gum and comparatively large quantity of maltose. The ash obtained from the roots on ignition was found to consist mostly of potassium salts. Chopra and co-workers (1934) investigated the plant and isolated a basic amorphous residue which gave alkaloidal tests. It could not be studied further due to its poor yield. Besides this they also isolated potassium salts and sugars. The diuretic and the soothing properties of the plant are probably due to the potassium salts and to the large quantities of mucilage present in the plant. Srivastva and co-workers (1941) isolated an oil (23 per cent. yield) from the seeds and it was classified as semidrying oil. The component fatty acids of the oil contain the following percentages of acids; linoleic 72, oleic 10, stearic 12, palmitic and myristic 6 per cent. Basu and others (1947) obtained an alkaloid having the empirical formula, $C_{3.4}H_{4.3}N_{1.36}O_n$, m.p. $216-17^{\circ}C$. and gave the reactions of a purine body.

No pharmacological or clinical studies have so far been carried out.

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LUFFA ACUTANGULA Roxb. (Cucurbitaceæ)

VERN.—Beng.—*Jhinga*, *Jinga*, *Sataputi*; Bomb.—*Gonsali*, *Jinga*, *Sirola*, *Turai*; C. P.—*Dorca*; Hind.—*Jinga*, *Sataputitorai*, *Torai*, *Turi*; Kumaon.—*Torie*; Mal.—*Djinji*; Pers.—*Khiyar*; Sans.—*Dhamargowa*, *Dharaphala*, *Dirghaphala*, *Gramya*, *Karkotaki*, *Koshataki*, *Kritawedhana*, *Rajakoshataki*, *Rajimatphala*, *Svaduphala*; Tam.—*Pekankai*, *Peypichukku*, *Pikunkai*; Tel.—*Birakaya*, *Burkai*; Urdu.—*Torai*.

This is a climbing plant which is met with in north-west India, Sikkim, Assam, and East Bengal and is cultivated in most parts of India. The fruit, for which the plant is grown, matures during the rainy season. Sowing should be made from March to the beginning of June. Rich soil should, if possible, be selected, and the seed sown in lines 5 ft. apart. When the young plants are about 4 in. high, supports should be given for them to climb on. Until the rains begin

the first sowing should be regularly watered. Two sowings, one early, the other late will keep up a supply from July till October (Watts).

The seeds possess emetic and purgative properties but to a much less marked degree than those of the variety, amara. The pounded leaves are applied locally in splenitis, haemorrhoids and leprosy. The juice of the fresh leaves is dropped into the eyes of children in grannular conjunctivitis and also to prevent the lids adhering at night from excessive meibomian secretion. In Cambodia the pounded leaves are applied locally in the treatment of ringworm. The fruit in combination with other drugs is prescribed internally as an antidote to snake-bite and the juice of the leaves is applied locally to the part bitten. Caius and Mhaskar found that the fruit is useless in the symptomatic treatment of snake-bite and the leaves are also useless as external application.

CHEMICAL COMPOSITION.—The earlier investigation was done by Dymock and Warden who found that the fruit contains a bitter substance lofein and the seeds contain a fatty oil. Grewal and Kochar (1943) investigated the Luffa seeds. They found that the average yield of the oil was 47 per cent. of the kernels and calculated in terms of the seeds was 23 per cent. The oil has the following characteristics; specific gravity 0.9212, refractive index n^{20}_D 1.4695, specific refractive power 0.5116, acid value 2.5^d, saponification value 196.5 to 197.5, unsaponifiable matter 1.67 to 1.7 per cent. Reichart Meisal number 0.392, Hehner number 92.0 per cent., acetyl number 12.2, Iodine value 5.1, mixed fatty acids have melting point 38°C. The seeds contain an amorphous saponin m.p. 198-200°C. and an amorphous white enzyme. The saponin is easily reduced by emulsin and more readily by the enzyme present in the seeds.

PHARMACOLOGICAL ACTION.—The saponin is toxic to frogs in doses of 0.2 gm. per kilogram body weight. The haemolytic effect of the saponin is quite comparable to that of Merck's saponin. It causes complete haemolysis of red blood corpuscles in an hour in 1 : 35,000 dilution, whereas the Merck's saponin causes complete haemolysis in 1 : 40,000. The saponin shows digitalis like action in concentrations of 1 in 1,000 in two hours. The alcoholic extract of the seeds was found to cause irritation in the intestines especially in the small intestines. As small a dose as 0.25 gm. per kilo. of the seeds in alcohol 1:1 caused vomiting and diarrhoea in dogs. The oil has a similar effect to the seeds. The crushed kernels also cause vomiting but are not so effective as the alcoholic extract. Whatever effect the plant possesses is due to the presence of the saponin in it.

References:—

(1) Watt, 1891, *Dictionary of Economic Products of India*, 94; (2) Hymock and Warden, 1890, *Pharm. Jour.*, 997; (3) Grewal Khem Singh, and Kochar, B. D., 1943, *Ind. Jour. Med. Res.*, 63.

LUVUNGA SCANDENS Ham. (Rutaceæ)

VERN.—Sans.—*Khankshika, Dhira, Dhmanaksholi, Jivaniya, Jivanti, Kakoli, Kayasthika, Kshira, Lavangalata, Madhura, Shitapaki, Svadumansi, Vayasolika, Vayastha.*

It is powerful scandent shrub armed with axillary solitary sharp and more or less recurved thorns. It grows in Eastern Bengal, Assam, Khasia hills,

Chittagong and Burma. The berries are sold in the bazars in Bengal under the name of Kakla. They form an important constituent of the group of remedies (Dashamool) of the Ayurvedic medicine. Here the roots and berries are considered to be sweet, oily and cooling, allay thirst, cure consumption, biliousness, trouble due to 'Vata', blood disorders and burning fevers which aggravate 'Kapha'. The berries are also used in preparing perfumed medicinal oils. The root and fruit are prescribed with other drugs in the treatment of snake-bite and scorpion sting. Caius & Mhaskar, however, found that they are equally ineffective in both these conditions.

CHEMICAL COMPOSITION.—The berries were examined by Mookerjee (1944) who isolated four crystalline neutral products from the petroleum ether extract. No substance of alkaloidal nature could be detected. It was also observed that only the mature fruit contained the crystalline product which were totally absent in the unripe fruit.

1. The crystalline substance is colourless and has the formula, $C_{11}H_{50}O_3$ (OMe), and m.p. $145^{\circ}C$. It occurs in long slender needles to the extent of 0.1 to 0.4 per cent. It has been shown to be identical with Xanthotoxin which was first isolated from *Fragara xanthoxyloides* and later on from *Ruta chalepensis*.

2. The second substance $C_{14}H_{12}O_3$ with m.p. $128^{\circ}C$. forms stout rhombic plates, the yield being 0.05 to 0.06 per cent. It has been shown identical with xanthyletin which has been isolated so far from *Xanthoxylum americanum*.

3. The third neutral substance melts at $151-52^{\circ}C$. and has the formula $C_{11}H_{14}O$ $(OCH_3)_2$. Further study of its properties suggests its identity with isopimpinellin.

4. The fourth compound $C_{15}H_{14}O_4$ (0.08-5 per cent.) is a new substance and has been named Luvangetin. It forms colourless plates with m.p. $108-9^{\circ}C$.

The chemistry of this plant deserves further study. Unless this is done no pharmacological studies can be taken up.

References:—

- (1) Mookerjee, A., Bose, U.P., 1944, *Jour. Ind. Chem. Soc.*, 181.

MADHUCA LATIFOLIA (Roxb.) Macbride (Sapotaceæ)

Syn. *Bassia latifolia* (Roxb.)

THE MAHUA TREE

VERN.—Beng.—*Ban mahuva*, *Mahula*, *Mahwa*, *Maul*; Bomb.—*Mahua*, *Moha*, *Mova*; Dec.—*Jangli moha*, *Moha*; Eng.—*Butter tree*, *Mahua tree*; Guj.—*Mahuda*, *Mahura*; Hind.—*Jangli moha*, *Jangli mohva*, *Mahua*, *Mahula*, *Mahwa*, *Maul*, *Mowa*; Kumaon.—*Mohwa*; Mal.—*Irippa*, *Irippapu*, *Kattirippa*, *Pu*, *Puvuna*; Mar.—*Maha*, *Mahwa*, *Mhowra*, *Moho*, *Mohwa*, *Mora*, *Mowda*, *Ranachamohachajhada*; Pers.—*Darakhtegulcha-kanesahrai*, *Gulechakan*; Sans.—*Atavimadhuka*, *Dolaphala*, *Garudapu*, *Guda pushpa*, *Loāhrapushpa*, *Madhava*, *Madhu*, *Madhuka*, *Madhusphuttila*, *Mahadruma*, *Rodhrapushpa*; Tam.—*Kattiluppai*, *Madugam*; Tel.—*Adaviyippa*, *Lappa*, *Madhukamu*, *Pedayippa*; Urdu.—*Mahuva*.

MADHUCA LONGIFOLIA (Linn.) Macbride (Sapotaceæ)Syn. *Bassia longifolia* Linn.

VERN.—*Mohuva*; Bomb.—*Mohwa, Mohi*; Dec.—*Moha*; Eng.—*Honey tree, Mahua of Southern India*; Guj.—*Mahuda, Movanujhada*; Hind.—*Moha, Mohua*; Mal.—*Irippa*; Mar.—*Ippichaphada, Mohachajhada, Mohwa*; Pers.—*Darakhtegulchakan*; Sans.—*Madhuka*; Tam.—*Iluppai, Iruppai, Kuligam, Kulisam, Madugam, Maduragam, Mavagam, Nattilupai, Seyilam, Tittinam*; Tel.—*Ippa, Pinnayippa, Sannayippa, Uriyippa*.

M. latifolia is a large deciduous tree, indigenous to the forests of the Central Provinces. It is cultivated all over India and it is also reported to be plentiful in Dehra Dun and Saharanpur Siwaliks, Oudh, Bihar, Chota Nagpur, Orissa, Madhya Pradesh, Madhya Bharat, Gujarat, Konkan, N. Kanara, South Mahratta Country, N. Circars and Deccan. It thrives on dry, stony ground and bears clusters of yellowish-white fleshy flowers. The fruits are green when unripe, and reddish yellow or orange when ripe. The tree is valued for its flowers, its fruits, its seeds and its timber and is of considerable economic importance. *M. longifolia* is another tree of the same natural order possessing practically the same properties. This is a large much-branched tree with a slightly furrowed bark, linear lanceolate glabrous leaves, small fleshy flowers and ovoid fruits. It is found in the forests of Western India from Konkans Southwards to Travancore and is common in Kanara, Malabar, Mysore, Anamalais and the Circars at low elevations.

CHEMICAL COMPOSITION.—*M. latifolia*.—The seeds contain 50 to 55 per cent. of a fatty oil. This oil is used by the Gonds and other Central Indian tribes for edible purposes and is not infrequently used as an adulterant of 'ghee'. It is also largely used as a lamp oil and is said to be well adapted for soap manufacture. The composition of the fats present in the seeds of *M. latifolia* has been worked out by R. G. Pelly (1912) at the Imperial Institute. The unsaturated acids yield on oxidation dihydroxy stearic acid with a m.p. of 130°C. No linolic acid could be found. The saturated acids have m.p. of 53°C. neutralisation value 205 and iodine value 12.7 per cent. On re-crystallisation from alcohol they yield nearly half their weight of stearic acid, some palmitic acid is also obtained. A saponin of the formula $C_{17}H_{26}O_{10}$ has also been separated from the seeds. The leaves contain a glycosidic saponin different from that obtained from the seeds has been reported. Traces of an alkaloid have also been found. The flowers form an important article of food, and a spirit is distilled from them. The flowers contain a fairly good quantity of sugar, enzymes and yeast. Church gives the following figures of analyses for air-dried flowers: Cane-sugar 2.2 per cent.; invert sugar 52.6; other substances soluble in water 7.2; cellulose 2.4; albuminoids 2.2; ash 4.8; water lost at 100°C 15.0; undetermined 12.6.

M. longifolia.—Seeds contain 40 per cent. of fatty oil, called 'bassia oil', of which about one-third is olein and two-thirds palmitin. More recent investigations show that about 55 to 57.8 per cent. of fat is contained in the seeds. About 60 per cent. of this fat is composed of olein and linolein and 40 per cent. is stearin and palmitin. After the oil is extracted, a sapo-glycoside called 'mowrin' is obtained from the residue. This has been isolated as a pale yellow powder soluble in all proportions in water and in methyl and ethyl alcohols. It is fairly toxic and has a specific action on the heart and circulation, similar in many respects to that of the drugs of the digitalis group (Moore and others). The fruit contains saccharose 4.6 to 16.2 per cent. and maltose about 2.39 per cent. Besides these, they also contain a lot of tannin and enzymes.

THERAPEUTIC USES.—Both *M. latifolia* and *M. longifolia* are used for practically the same purposes. Because of their tannin content, they act as astringents. They are largely employed as a lotion in chronic ulcers, as a gargle in bleeding and spongy gums, and in acute and chronic tonsillitis and pharyngitis. A drachm of the liquid extract in 10 ounces of water makes a useful gargle. The leaves have also astringent properties. The ashes of the burnt leaves mixed with 'ghce' are often used as a dressing for burns and scalds in the indigenous medicine. Internally, the bark is employed in diabetes mellitus with much benefit. The flowers are expectorant and nutritive, and are useful in chronic bronchitis, and wasting diseases. The oil is often used as an application in chronic rheumatism. It acts as a laxative and may be used in habitual constipation and haemorrhoids.

ECONOMIC ASPECTS.—The economic importance of the flowers and fruits cannot be overestimated. The flowers of *M. latifolia*, are used for the manufacture of alcohol on a large scale. These flowers are considered to be good and cheap raw materials for the manufacture of power alcohol and are now being very largely employed in Bihar and Orissa, the Bombay Presidency and in Bengal.

References:—

(1) Fowler *et al.*, 1920, *J. Ind. Inst. Sci.*, 3, 81; (2) Fowler and Dinanath, 1923, *J. Ind. Inst. Sci.*, 7, 273; (3) Roberts, 1931, *Vegetable Materia Medica of India and Ceylon*; (4) Moore, Sowton, Baker-Young and Wester, 1911, *Biochem. Jour.*, 5, 94; (5) Pelly, 1912, *Jour. Soc. Chem. Ind.*, 31, 98.

MALLOTUS PHILIPPINENSIS Muell. Arg. (Euphorbiaceæ)

KAMALA; ROTTLERA

VERN.—Arab.—*Kampilch*, *Kinbil*; Assam.—*Gangai*, *Puddum*; Beng.—*Kamalagundi*, *Kamila*, *Tung*; Bomb.—*Kamala*, *Kamela*, *Kapela*, *Ruhin*, *Shendri*; C. P.—*Chamargular*, *Ningur*, *Rauni*, *Rori*; Darj.—*Sinduri*; Dehra Dun.—*Raini*; Eng.—*Monkey face tree*; Hind.—*Kamala*, *Kambhal*, *Kambila*, *Kamela*, *Rauni*, *Ruin*, *Rulu*; Kash.—*Kaimbil*; Kumaon.—*Rauni*, *Reru*, *Riuna* *Roli*; Mal.—*Chenkolli*, *Kapila*, *Kuramatukka*, *Manjana*, *Ponni*, *Poonagam*, *Tavitu*; Mar.—*Shendri*, *Shindur*; N. W. P.—*Purvahung*, *Sinduria*; Pers.—*Kambela*; Peshawar.—*Kambaila*; Punj.—*Kamal*, *Kambal*, *Kamela*, *Kumila*, *Reini*, *Rulya*; Sans.—*Bahupushpa*, *Chandra*, *Kampilla*; Tam.—*Avam*, *Kabilam*, *Kamala*, *Kambosam*, *Kapila*, *Kungumam*; Tel.—*Adavigubbatuda*, *Benduruppu*, *Chendiramamu*, *Kunkuma*; Urdu.—*Kalileh*.

Glandulae rottlerae or Rottlera or Kamala consists of minute red glands and hairs of the fruit of an evergreen tree, *M. philippinensis*, belonging to the Spurge family. It is a small evergreen shrub which is widely distributed throughout the tropical parts of Asia and Australia. It is collected in large quantities in Indo-China and is exported to Europe. The plant grows throughout the plains of India and Ceylon. In Orissa, Bengal and Bombay it grows abundantly and it has been used as a dyestuff for centuries. The Arabian physicians called it 'wars' or 'wuras'

and knew its anthelmintic properties as far back as the 10th century. It was introduced into Europe only sixty years ago, and at one time it gained a considerable reputation as an anthelmintic. It was included in the British and United States Pharmacopoeias, but further experience showed that its action was uncertain and it was discarded. According to Waring it has little or no effect on intestinal parasites other than tapeworms. The drug as sold in the bazar is highly adulterated.

CHEMICAL COMPOSITION.—Kamala is a beautiful purplish-red or brick-red powder having no taste or odour. It is insoluble in cold water and only slightly soluble in boiling water, but it is freely soluble in alkalies, alcohol and ether, forming a deep red solution. A large amount of work has been done on the chemical composition of this substance and a number of substances have been isolated. The most important constituent is a brownish red resin composed of a crystalline substance called *rottlerin*, $C_{33}H_{30}O_9$. It occurs in reddish yellow laminar plates which are readily soluble in ether but insoluble in water. When acted on by hot caustic alkalies, rottlerin yields methyl-phloroglucin and by reduction with zinc powder and soda, dimethyl phloroglucin. Filicic acid and kosotoxin also yield these substances. Besides rottlerin there is another substance called *isorottlerin* which is probably impure rottlerin. The drug also contains a yellow crystalline substance and a yellow and a red resin and wax. It contains traces of a volatile oil, starch, sugar, tannin, oxalic and citic acids.

The kernels of the seeds yield 48.8 per cent. oil with very good drying properties. The oil has got the following constants: Specific gravity, at 33°C. 1.5156, Acid value 11.3, Saponification value 207.6, Iodine value 157.3, Acetyl value 46.8, Hehner value 96.1, Unsaponifiable matter 1.9 per cent.

PHARMACOLOGICAL ACTION.—Semper (1910) tested the action of this drug on frogs, tadpoles and worms and found that it had distinctly toxic effect on these animals. The symptoms produced were similar to those produced with male fern, though they were of a comparatively mild character. The paralysing effect was very remarkable. The drug irritates the gastro-intestinal tract and even in therapeutic doses produces considerable nausea, and increases the peristaltic movements of the intestine; it therefore acts as a good cathartic. Experiments on dogs show that it is absorbed very slightly from the gastro-intestinal tract.

THERAPEUTIC USES.—The drug is used to remove ascaris and threadworms and is generally given without any preliminary preparation, dietary or otherwise. The powder is mixed with milk, curd or honey or dissolved in an aromatic water before it is swallowed. In doses of 2 to 3 dr., it may cause nausea and griping and free purging is produced so that no after purgative is necessary. There are as a rule no after-effects. Caius and Mhaskar (1923) tried it in a series of cases and found it to be useless against hookworms, roundworms and whipworms, although earlier observers have claimed it to be a good vermifuge against these worms. Good Kamala powder is, however, said to act well against tapeworms. Probably its effect would be enhanced if it is given after preliminary preparation such as dieting and purgation, as is the case with male fern. It is a mild drug and is indicated in children and debilitated individuals in whom extract of flax mas is not advisable.

References:—

(1) Chopra, R. N., and Chandler, A. C., 1928, *Anthelmintics and their Uses in Medical and Veterinary Practice*, William Wilkins & Co. (2) Kartar Singh, and Brij Mohan Saran, 1942, *Curr. Sci.*, 380.

have deobstruent and resolvent properties. The flowers and leaves are applied as a poultice to relieve nervous headache. The juice of the leaves administered internally is said to be anthelmintic, diuretic and emmenagogue and is thought to relieve cold swellings and expel the humours which give rise to them. In the Punjab, the seeds are prescribed in rheumatism. In Bombay, strings of the seeds are suspended over doors and verandahs during the prevalence of epidemics to avert the disease. In America, a decoction of the leaves has been employed in hysteria and is believed to be astringent and stomachic. The leaves and bark are used internally and externally in leprosy and scrofula, while a poultice of flowers is believed to have anthelmintic properties and to be a valuable remedy in eruptive skin diseases. In Indo-China the kernel of fruit is prescribed in certain forms of fevers and in urinary troubles.

CHEMICAL COMPOSITION.—The early investigation of the bark was done by Jacob (1880) who stated that the activity of the bark resides in the fibre (or inner bark) and this alone should be employed. The active principle is a yellowish white resin. The drug was considered a good anthelmintic and a fluid alcoholic extract or a tincture was considered to be a valuable preparation for medicinal purposes. Siddiqui and co-workers (1948) reinvestigated the plant and found that in contrast to the nim fruit, the bitter constituents of the bakayan fruit are present in the pericarp and are absent in the kernel. They have isolated an amorphous bitter principle (yield 0.7 per cent.) and named it bakayanin, $C_{21}H_{34}O_4$, which melts indefinitely from 85 to 118°C. It is bitter in dilutions up to 1 in 10,000. Apart from the bitter principle an insoluble non-bitter acidic fraction and a neutral fatty fraction were also obtained. The latter yielded sterol (m.p. 137°C.) which is identical with the sterol isolated from nim blossoms. The fixed oil (solvent extracted) showed specific gravity 0.9165, refractive index 1.435, saponification equivalent 275.3 and iodine value 138.65.

PHARMACOLOGICAL ACTION.—Steju and Pindi (1929) carried out preliminary experiments on the toxicity of the fruit of *M. azedarach*. The fruit produced symptoms like paralysis and narcosis in cats, dogs and sheep. The poison was readily extracted by ether and chloroform and was thermostable. It seemed not to be an alkaloid nor a glycoside or an albuminoid. Feeding of the small quantities of tannic acid with the fruit had an inhibitory effect upon its activity although the poison seemed not to have been isolated in pure form. This plant is only used as a household remedy by people in the area in which it grows against common minor ailments both as an external application and internal use. It has some insecticidal action which has not been properly investigated. As compared to Nim, little work has been done on this plant.

References:—

- (1) Jacob, *Year Book of Pharmacy*, 1880, 206; (2) Amir Chand, Mitra, and Siddiqui, 1948, *Jour Sci. Industr. Res.*, 69; (3) Morr and Grant, 1930, *J. & Pros. Roy. Soc. New South Wales*, 153; (4) Steju, and Pandl, 1929, *Trans. Roy. Soc. South Africa*, 295.

MORINGA PTERYGOSPERMA Gaertn. (Moringaceæ)

VERN.—SANS.—*Sobhanjana*; Hind.—*Shajnah, Shajna, Segva*; Beng.—*Sôjna*; Uriya—*Munigha, Sajina*; U.P.—*Sahajna*; Punj.—*Sanjna*; Bomb.—*Sujna, Sanga*; Burm.—*Dandalonbin*; Sing.—*Murunga*.

The medicinal virtues of this plant have long been known and appreciated in India. It has been frequently mentioned by Chakradatta, also in the 'Bhavaprakasa', and in other Sanskrit works on medicine. Almost all the parts of

the plant, *e.g.* roots, leaves, seeds, flowers, etc., have been used sometime or other in the treatment of various ailments in the indigenous system. The seeds are called 'sweta maricha' or white pepper and have been described as acrid and pungent. They are also said to be stimulant and are given in cases of ascites resulting from enlargement of the liver and spleen.

The oil expressed from the seeds is used externally for relieving pain of the joints in gout and acute rheumatism. A decoction of root bark is recommended for internal administration by Chakradatta, and in the 'Bhavaprakasa' for ascites, enlarged spleen or liver and calculus affections. It is also directed to be used externally as a poultice, plaster or decoction over inflamed parts and is supposed to reduce these swellings. The fresh juice of the root bark is recommended for the same diseases as a decoction, and is also said to relieve otalgia when poured into the ears.

The root of the young tree is still prescribed by the indigenous practitioners in small doses in a variety of conditions like intermittent fever, epilepsy, hysteria, palsy, chronic rheumatism, dropsy, enlargement of the spleen and dyspepsia. Sometimes the fresh root is mixed with mustard seeds and green ginger for external use as a counter-irritant and blistering agent. The root has also been recommended by Hakims in the treatment of soreness of the mouth and throat and pain in the gum due to dental caries. It has been used as an abortifacient, a rubefacient and counter-irritant in rheumatic cases and enlargement of the liver in children. The root in the form of a compound spirit has been successfully used in fainting, giddiness, nervous debility, spasmodic affections of the bowels, hysteria and flatulence. The gum has been used in the Punjab in rheumatism and as an astringent. The Hakims administer the fruit in affections of the liver and spleen, articular pains, tetanus, debility of nerves, paralysis, pustules, patches, leprosy, etc.

The young leaves are used as food. They have been used with other ingredients in the treatments of dog-bite and scurvy. They have also been used in catarrhal affections. The pods have been used as a vegetable for edible purposes and are supposed to act as a preventive against intestinal worms. The flowers are commonly used as food. These are sometimes boiled with milk and the preparation is used as an aphrodisiac. Mohammedan writers describe the flowers as hot and dry, and consider them useful in cold humours and swellings. They are supposed to be tonic and diuretic and to increase the flow of bile. The juice has been prescribed with milk as a diuretic, antilithic and digestive, and is useful in asthma.

The *M. pterygosperma* tree is fairly large and pretty and grows wild in the sub-Himalayan tract from the Chenab to Oudh. It is commonly cultivated in India and Burma. The leaves, flowers and fruits are all eaten as vegetables. The tree produces flowers and fruits in abundance twice or at times thrice a year. The corky, grey bark is about an inch thick and has longitudinal cracks. It yields a coarse fibre which is utilised in preparing mats, paper or cordage. The roots are pungent and have the taste of horse-raddish. The wood of the root is soft, porous and yellowish, and has the same properties but in a less degree. The bark of the root is thick, soft and reticulated; it is light brown externally, soft and white internally. The gum is opaque and white when it first exudes but on exposure to

air soon changes to pink, dull red or mahogany colour on the surface. The samples vary in shape from stalactite pieces to tears and appear to be only produced upon the trees which have been injured by insects. The taste is bland and mucilaginous. The gum becomes very friable in dry air and is tough in a damp climate. It holds 20 per cent. of its weight of water. The gum belongs to the tragacanth or hog gum series, but on account of its dark colour, it has not much value in European commerce. It is insoluble in water. The seeds yield on simple pressure a clear, limpid, almost colourless oil, rather thick at ordinary temperature. This oil has a specific gravity of 0.912 to 0.915 at 60°F, and is almost devoid of odour and flavour, saponifies slowly and does not turn rancid. It is one of the best lubricants for fine machinery and is highly valued by watch-makers. The oil from this species, and that from *M. aptera* Fuss., are commercially known as Ben oil. It is a remarkable fact that, though the tree is cultivated to a great extent in India, the oil is seldom extracted here and so it does not form an article of export. India might easily and apparently profitably supply the whole world with Ben or Moringa oil, and one can reasonably hope that attention may be directed to the subject. It is also highly esteemed by perfumers, for its great power of absorbing and retaining even the most fugitive odours.

CHEMICAL COMPOSITION.—A preliminary extraction with solvents gave the following extractives: petroleum ether 0.71 per cent., sulphuric ether 6.47 per cent., chloroform 0.68 per cent., and absolute alcohol 2.17 per cent. The alcoholic extract gave strong reactions for alkaloids. An assay of the bark showed the presence of 0.105 per cent. of total vegetable bases. For isolation of the bases the bark was extracted by cold percolation with rectified spirit, the alcohol distilled off and finally concentrated *in vacuo*. The residue was extracted with dilute acid, filtered, the extract made alkaline and extracted with ether and finally with chloroform. The residue from the solvents was dissolved in alcohol, neutralised with HCl and evaporated. The dry residue was extracted with hot chloroform. The insoluble portion was repeatedly recrystallised from alcohol and the hydrochloride was obtained in colourless glistening plates, m.p. 254.2°. The platinic chloride crystallised in yellow rectangular plates with m.p. 221°, the picrate crystallised in yellow woolly needles m.p. 195°. The free base remained liquid at room temperature and could not be crystallised. The hydrochloride of the second base, soluble in hot chloroform, has not been obtained crystalline, but it had a strong physiological action.

Rangaswami and co-workers (1946) investigated the flowers and obtained from the petroleum ether extract a wax, m.p. 69-72°C., acid number 10.5, saponification number 29.8, unsaponifiable matter 75.5 per cent. Rao and George (1949) while working with the alcoholic extract of the fresh roots of the plant found that the extract exhibited strong antibiotic activity. They isolated the substance responsible for this activity and gave the name of *pterygospermin* to it. It is a reddish brown oil and is most active at pH of 5 and the activity decreases as the pH approaches 8. The substance has antibacterial activity against gram positive and gram negative organisms, no growth taking place in a concentration of 5 parts per million against *Staphylococcus aureus*. The presence of cysteine did not reduce the antibacterial activity and in the presence of nucleic acid (0.1 per cent.) the activity was increased. Good antifungal activity was also exhibited by this antibiotic. This substance resembles antibiotics in activity and needs further study.

PHARMACOLOGICAL ACTION AND THERAPEUTIC USES.—The pharmacological action of the vegetable bases isolated from *M. pterygosperma* has been worked out by Chopra and De (1932, unpublished). The crystalline base has little or no physiological action, whereas the amorphous base shows a marked activity, and closely resembles adrenaline and ephedrine in its effects. This base thus belongs to the sympathomimetic group of bases. It acts on the sympathetic nerve endings all over the body producing a rise of blood pressure, acceleration of heart-beat and

constriction of the blood vessels. Its effect on the heart is mainly through the sympathetic though the myocardium may also be slightly stimulated. It also inhibits the tone and movements of the involuntary muscle of the gastro-intestinal tract and the bronchioles. The effects of sympathetic stimulation were also found in the action of this base on other organs. It produces slight diuresis on intravenous injection in animals, dilates pupils and is detoxicated by the liver. Very large doses depress the vasomotor nerve-endings. This base differs from adrenaline in that it produces little or no rise of blood pressure after ergotoxine whereas adrenaline produces a fall under similar conditions. The sympathomimetic base isolated from *M. pterygosperma* is, however, very much weaker in its action than adrenaline or ephedrine.

The amount of bases present in the alkaloid are very small and its practical utility in therapeutics is doubtful unless the quantity of active principles is increased by suitable cultivation.

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MYRSINE AFRICANA Linn. (Myrsinaceæ)

VERN.—Arab.—*Baibarang*, *Baring*; N. W. P.—*Chupra*, *Guvaini*, *Paharicha*; Kash.—*Gugil*; Punj.—*Atulgan*, *Bandaru*, *Bcbrang*, *Branchu*, *Chachri*, *Gugul*, *Karuk*, *Khushin*, *Kokhuri*, *Pratshu*, *Vavarang*.

It is a small evergreen shrub found in Afghanistan on the Salt Range, and the outer Himalayas from Kashmir to Nepal, at an altitude from 1,000 to 8,500 ft. above the sea level. The berries of the shrub are used in Hindu medicine as anthelmintic, especially for expulsion of tapeworms. An ointment prepared from the berries is considered effective against ringworm and other diseases of the skin.

CHEMICAL COMPOSITION.—Verma and co-workers (1936) investigated the berries by extraction with various organic solvents and isolated a crystalline material of golden colour (yield 3 per cent., m.p. 143-44°C.). It was identified as embellic acid through preparation and identification of its many derivatives. The berries when extracted with rectified spirit deposited along with colouring matter, a white crystalline substance, m.p. 228-30°C., yield 1 per cent., which has been identified as quercitol.

The seeds from Abyssinia were found by Anon to contain 4.8 per cent. of embellic acid (to which it owes its anthelmintic properties) and about 1 per cent. of quercitol. No pharmacological work or clinical trials have been carried out.

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PEGANUM HARMALA Linn. (Zygophyllaceæ ; Rutaceæ B.H.)

SYRIAN RUE

VERN.—Arab.—*Harmal, Hurmul*; Beng.—*Isband*; Bomb.—*Hurmal, Hurmaro, Isband*; Hind.—*Harmal, Isband-lahouri, Kaladana, Lahouri hurmul*; Mar.—*Harmal*; Pers.—*Isband, Isband*; Punj.—*Hurmul, Isboundlahouri, Lahouri hurmud, Spelanc*; Sind.—*Hurmul*; Tam.—*Simailyalavinai, Simaiyaravandi*; Urdu.—*Isband*.

This is a bushy herb, one to three feet in height, growing wild all over North-Western India, Sind, the Punjab, Kashmir, Agra and the Western Deccan. It is also distributed to Arabia, North Africa, Hungary and Spain. Large quantities of the seeds are imported into India from Persia, and they yield a red dye. The drug, as found in the bazar, consists of the seeds mixed with capsules. In the indigenous medicine 'harmal' is described as alterative, purifying, aphrodisiac and lactagogue. There is reference to show that the seeds were used by the ancient Greeks as they are to this day in India. The powdered seeds were used as anthelmintics against tapeworms.

CHEMICAL COMPOSITION.—The seeds contain three alkaloids—harmine, harmaline, and harmalol to the extent of 4 per cent. Harmaline occurs in largest amounts being $\frac{2}{3}$ the quantity of the total alkaloids; harmalol occurs only in traces, harmaline, $C_{13}H_{14}ON_2$, crystallises in colourless or pale yellow glancing prisms, m.p. $239-40^{\circ}C$. Harmaline on demethylation yields the phenolic base harmalol, $C_{12}H_{12}ON_2 \cdot 3H_2O$, m.p. $212^{\circ}C$. It also occurs in the seeds and crystallises from water in brown needles and is readily soluble in hot water or alkaline liquids and is oxidised in the air. On reduction harmaline yields tetrahydro harmine, $C_{13}H_{16}ON$, m.p. $199^{\circ}C$. and on gentle oxidation is converted into harmine. Harmine, $C_{13}H_{12}ON_2$, m.p. $266^{\circ}C$. crystallises in colourless rhombic prisms from methyl alcohol. On demethylation harmine yields the phenolic base harmol, $C_{12}H_{10}ON_2$, m.p. $321^{\circ}C$. A new alkaloid peganum has also been reported by Tutaev (1938) but no description of the alkaloid is available. Resenfield and co-workers (1936) isolated peganine from the blossoms and stems of the plant and was found to be identical with peganine (vasicine).

The possible therapeutic application of harmala alkaloids as protozoacidal agents, coronary dilators and ecbolics and in nervous diseases aroused considerable interest for the preparation of homologues of these alkaloids. Coulthard and co-workers (1933) prepared large number of allyl harmols.

PHARMACOLOGICAL ACTION.—Flury (1910) investigated the anthelmintic properties of the alkaloids occurring in the seeds of *P. harmala*. Harmaline was found to have some anthelmintic action probably by paralysing the musculature of the parasites. Both harmine and harmaline paralysed the skeletal and cardiac muscles of frogs. In warm-blooded animals, harmine and harmaline caused convulsions, salivation, interference with respiration and depression of temperature. Harmaline stimulated the respiration in small doses, but in large doses paralysed it. The minimal toxic dose of harmaline for rabbits was determined to be 0.23 gm. per kilo. of body weight. As stated in *Henry's Plant Alkaloids* (1924) the exact knowledge of the pharmacology of the alkaloids is largely due to the work of Gunn and his collaborators. In a summary of his results Gunn states that in large doses harmine causes tremors and clonic convulsions, the latter occurring

without marked increase in spinal reflex excitability in frogs. With poisonous doses the convulsions are followed for a short time by motor paralysis, due to depressant action on the central nervous system. The respiration is paralysed and in mammals there is a fall in temperature. Harmine induces a fall in blood pressure chiefly due to weakening of the cardiac muscle. It arrests the perfused heart in diastole and diminishes the contractions of most forms of smooth muscle with the exception of the uterus, which, particularly in the rabbit, contracts powerfully. It is more toxic to most protozoa than quinine, Harmaline (dihydro-harmine) is about twice as toxic to most laboratory animals as harmine, but the addition of two atoms of hydrogen affects the degree of activity rather than its pharmacological character, as is also the case for tetrahydroharmine. The minimum lethal doses of the three bases for the rabbit are in the following ratio: harmine, harmaline and tetrahydroharmine—2:1:3. The character of the action is still unaltered in tetrahydronorharmine, but in changing the ethers, harmine and harmaline to the respective phenols, harmol and harmalol, the capacity to induce clonic convulsions disappears, and the two phenols cause a progressive paralysis of the central nervous system without initial stimulation. The protozoacidal action is also much reduced. In harmol, alkyl ethers (homologues of harmine), the initial stimulant action of harmine diminishes as the weight of the alkyl group increases and at nonylharmol the action is purely depressant. Dilatation of the coronary vessels of the perfused heart shown by tetrahydroharmine is intensified with the alkylharmols attaining a maximum at amylharmol. The harmala and cinchona groups of alkaloids exhibit much similarity in action in spite of their dissimilarity in chemical constitution, and it is suggested that in cases of this kind the action must be due to a common chemical factor in the tissues concerned. Raymond-Hamet has made a special study of the vascular action of the harmala alkaloids and certain of their proximate derivatives, including their influence on the pressor and other effects of adrenaline in comparison with that of yobyryne and ketoyobyryne.

The possible therapeutic applications of these alkaloids as protozoacidal agents, coronary dilators and ecbolics, and in nervous diseases, for example in the treatment of post-encephalitic conditions, have been discussed by a number of authors. The alkylharmols, referred to above, form part of an extensive series prepared by Coulthard, Levene and Pyman and tested by these authors for bactericidal properties and by Coulthard for amoebicidal action. Each kind of activity increases to a peak as the series ascends and then diminishes. In the O-n-alkyl series the peak is at O-n-butylharmol for *Bacillus typhosus*, at O-n-amylharmol for *Staphylococcus aureus* and at O-n-nonylharmol for *Entamoeba histolytica*. In the O-w-diethylaminoalkyl series the peak for *B. typhosus* is at O-w-diethylaminononylharmol. No trypanocidal or anti-malarial action was observed in a selection of the compounds tested.

The physiological action of the alkaloids and of aqueous extract of the crude drug has been studied. A solution of the alkaloids (0.0001 per cent.) and the aqueous extract of the drug (0.0002 per cent.) caused a marked increase in the

growth of yeast cultures (*Saccharomyces ellipsoideus* and *S. beticus*) and also caused modifications in the cell structure (increase in size which persisted when the cultures were later grown in normal media). Solutions of the pure alkaloids, inactivated intestinal parasites (*Ascaris lumbricoides* and *Macracanthorhynchus hirudinae*), while the aqueous extract caused excitation. Parenteral administration of the alkaloids caused psychomotor excitation in the dog and rat, and the effect of oral administration differed in that tremor or rigidity did not occur. A 0.00001 per cent. solution of harmaline stimulated the contraction of an isolated rat uterus, while mixture of the alkaloids was active in concentrations of 0.000001 per cent. Harmine caused temporary hyperglycemia in a dog when administered in doses of 5 mg./kg. Harmine also modified the action of alloxan by stimulating the hyperglycemic and moderating the hypoglycemic phase. Tutaev and Makarova (1938) made the biological study of the new alkaloid Peganum isolated from *P. harmala*.

The effects of the injection of peganum are compared with those of harmine. Both cause tremor and convulsions in warm-blooded animals when toxic doses are administered. Peganum depresses the central nervous system and its toxic dose is 6 mg. per 20 gm. body weight. The tremor and convulsions are due to an excitatory action on the upper spinal cord. The alkaloid stimulates the ventricular muscle of the frog's heart and in strong concentrations the heart stops in systole. It also stimulates the activity of the smooth muscle of the intestine and uterus of rabbits. The site of action on smooth muscle is probably the muscle fibre itself.

THERAPEUTIC USES.—*P. Harmala* seeds have been used as a remedy for tapeworm in man and in the treatment intermittent and remittent fevers. Gunn and Marshall say that the drug is useful in chronic malaria but is not so effective in acute cases. Harmine by itself was also found to be reasonably efficient in certain relapsing cases. Harmaline used in patients suffering from both acute and chronic types of malaria in the Carmichael Hospital for Tropical Diseases did not produce any appreciable effect either on the malarial parasites or on the clinical symptoms of the disease.

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PIPER BETLE Linn. (Piperaceæ)**BETEL LEAF**

VERN.—Arab.—*Tanbol*; Beng.—*Pan*; Bomb.—*Pan*, *Vilyadele*; Eng.—*Betel leaf vine*, *Betel popper*; Hind.—*Pan*, *Tambuli*; Mal.—*Gryashya*, *Nagavalli*, *Tambulam*, *Vettila*, *Vitika*; Mar.—*Pan*, *Videchapana*; Pers.—*Bargetanbol*, *Tanbol*; Sans.—*Bhakshyapatra*, *Bhujangalata*, *Bhujangavalli*, *Divablishta*, *Kalaskanda*, *Nagavalli*, *Nagavallika*, *Nagini*, *Parna*, *Vitika*; Urdu.—*Pan*.

Pan, the chief ingredient of the betel morsel (Pan-Supari), belongs to the Piperaceæ family and is widely cultivated in Madras, Central Provinces, Bengal, Orissa, Bombay, U. P. and Burma. The use of betel leaf can be traced as far back as two thousand years. It is described in the most ancient historic book of Ceylon, the Mahavasma, which is written in the Pali language. It is mentioned that in the year 504 B.C. a princess made a present of betel to her lover. During the combat between Duthagamini and Malabaris in the year 161 B.C. his enemies seeing his blood-red lips due to chewing of betel, got the erroneous impression of having wounded him.

MEDICINAL PROPERTIES.—Pan or betel leaf (*Piper betle*) has been described from ancient times as an aromatic stimulo-carminative (Katu), astringent and aphrodisiac (Kamagnisandipanam). The leaf produces an aromatic volatile oil containing a phenol called chavicol which has powerful antiseptic properties. The alkaloid arakene has properties resembling cocaine in some respects. The betel leaf is believed in as a common household remedy for various ailments. It is sometimes applied over the temporal regions for its analgesic and cooling effects to relieve intense headache. A local application is recommended for inflammatory swellings such as orchitis, arthritis, mastitis. The application of leaves smeared with oil is said to promote secretion of milk when applied on the breasts of lactating women. In pulmonary affections of childhood and old age, leaves soaked in mustard oil and warmed are applied to the chest in order to relieve cough and dyspnoea. Its local application is considered to be a useful adjunct in the treatment of hepatitis, orchitis and sore throat. The fruit is sometimes mixed with honey and taken as a linctus to relieve irritating throat cough.

BETEL AND SUPARI IN SOCIAL LIFE OF INDIANS.—Pan-supari plays an important role in the daily social life of Indians. The custom of offering it to guests and visitors is a common courtesy amongst Orientals and has been prevalent in many parts of India from very ancient times and it exists amongst all sections of society to the present day. It is a common custom to offer pan-supari before and after meals to guests and on account of its carminative and sialogogue properties it is a digestive when taken after a heavy meal. Pan-supari, especially the pan is very commonly recommended by Ayurvedic physicians to stimulate sexual desire. Partly owing to its aphrodisiac properties and partly on account of its deodorant and exhilarating properties, pan-supari came to form a part of the ritual, with which a wife welcomed her husband. This custom still exists to some extent

amongst certain sections of society. In some of the religious books of the Hindus the duties of a wife are described in the following terms:

"The housewife must light the lamp and nicely prepare the bed. She must put on clean clothes, apply *sindhura* (vermilion) to her forehead and chew pan mixed with the usual spices. She must give him milk boiled with sugar, nutmeg, saffron, almond and musk and also betel nut and spices wrapped in pan (Betel leaf)".

This use of betel morsel sweetens her own breath and produce exhilaration and aphrodisiac effects in the husband. This custom has spread to prostitutes who offer pan-supari to their visitors. The custom of chewing betel morsel is widely prevalent in certain parts and there are many persons in this country who chew it all the time they are awake. It is carried and offered to friends just as Europeans offer cigarettes. While the leaf possesses aphrodisiac properties the thin stalk is believed to have contrary effects and is supposed to produce sterility. This is why it is removed when the morsel is prepared.

EXTENT OF ITS USE.—No other substance is craved for in the East with the same ardour as a betel leaf. There are many betel chewers who would rather give up their food than forego the betel morsel. The enormous extent of the practice of chewing betel in this country and the large quantities consumed give it an important position amongst accessory food substances. The areas of highest consumption are the eastern and southern parts of the Konkan coast, Kanara, the Malabar coast as far as Cape Comorin, Travancore, Ceylon, Coromandel coast, Assam and Bengal. The use also extends to the Madhya Pradesh, the Punjab, the Uttar Pradesh and the south-east Himalayas. On the west its use extends right up to the river Indus. According to a moderate estimate there are between 5 to 10 million betel chewers in this country. It is not consumed to the same extent in all parts of the country. Its use, for instance, is more extensive on the east coast than in the interior and northern parts of the country. In parts of the Punjab and North West Frontier Province the practice is considered a luxury and it is taken only on festive occasions. The passion for the leaf is common to all, both men and women of all ages, classes and religions. The habit is often started during childhood and may be continued till death. In Assam there are certain tribes who consider that no one can speak Assamese until he begins chewing betel. There are many who chew it at all times, at work or rest.

MODES OF PREPARATION AND CONSUMPTION.—Betel morsels are not always prepared fresh, but ready-made morsels are kept at home and also for sale in the betel-shops. In many households it is regarded as a duty of the female members to prepare and offer it to the family and guests, and a small box containing the implements and ingredients necessary for preparing the morsel is kept ready. The betel leaf is consumed in a fresh state, the old deteriorated leaves are believed to lose their properties. Frequent moistening preserves the plucked leaves and keeps them fresh for weeks, the leaves which by this process assume a yellowish colour are preferred. The betel morsel presented to visitors on ceremonial

occasions is composed of a piece of areca nut and a certain amount of burnt lime, a few spices and aromatics, and it is very often covered with gold or silver leaf. Some people add tobacco in addition to the ordinary constituents. In the process of chewing, the morsel is pushed from one side of the mouth to the other, it is masticated, pressed against or between the teeth in order to remove the juice, and it may protrude between the lips. The amount of different ingredients in the morsel differs with individuals. The areca nut constitutes one half or even more of the total weight of the morsel, the balance being made up with betel leaf spices and lime. Generally one large betel leaf or one and a half of the smaller leaves are used in making one morsel to which half to one grain of lime is added. The maximum amount consumed in one day may amount to two hundred leaves in adults, these contain approximately 20 to 30 nuts; moderate consumers may use from two to ten morsels.

CHEMICAL COMPOSITION.—Kemp (1890) tested the essential oil from some Bombay leaves and found it to be slightly laevo-rotatory with a specific gravity of 0.9404 at 28°. More recent work with the leaves from other places (Manila, Java, Siam, etc.) shows that the leaves contain starch, sugars, tannin, diastases (0.8 to 1.8 per cent.) and an essential oil (Betel Oil) to the extents of even 4.2 per cent. in some leaves. The essential oil is a light yellow liquid of aromatic odour and sharp burning taste. The specific gravity varies from 0.958 to 1.057. The oils from the Java or the Manila leaves were found to be rich in phenols (nearly 55 per cent.). The essential oil present gives rise to a sensation of warmth and well-being in the mouth and stomach. It is also known to produce a primary stimulation of the central nervous system, followed by a kind of inebriety in large doses. The presence of a fairly large quantity of diastase in the betel leaves is significant and is likely to play an important part in starch digestion.

Pharmacological Effects of Betel Chewing

SYMPTOMATOLOGY.—Chopra and co-workers (1942) have carefully studied over one thousand individuals who were in the habit of taking betel morsel habitually. This series included persons of all ages, races and occupations. The following description of the symptomatology from using the betel morsel is based on personal observations recorded in this series. The first apparent effect of the process of chewing pan is an abundant flow of saliva which mixes with the constituents of the morsel. Some people spit it out while other swallow it. The process of chewing is repeated for some time and in the case of a hard nut there may be some difficulty in cracking it. The morsel is chewed until only a few ligneous fibres are left which are thrown out. Persons who are not accustomed to the habit may experience a disagreeable, acrid and burning taste, and a feeling of constriction in the throat just after taking it. It may lead to roughness or even slight ulceration of the tongue and the buccal mucosa. These unpleasant effects are less and less apparent as the individual becomes accustomed to the habit, and they are followed by agreeable sensations and a feeling of well-being. The perception of taste also becomes temporarily

dulled on account of the presence of the essential oil contained in the leaves, and to the astringent action of the lime. The red coloration of the saliva is due to the colouring matter of the nut, which manifests itself under the influence of the alkali of the lime. The usual mixture of areca nut, betel leaf and lime imparts a red brown colour to the saliva, while the morsel containing betel leaf, areca nut, gambir catechu, and lime gives rise to blood-red colour. After the initial effects of the excitation of the salivary glands and the irritation of the mucous membrane of the mouth have passed off, a pleasant odour lingers in the mouth, which is regarded as one of the charms of this habit. Besides the pleasant odour in the breath the morsel produces a mild degree of general stimulation. In those who are not accustomed to the use of areca nuts a sensation of uneasiness, stifling (sometimes amount to faintness) tremors and sweating is often produced. The symptoms are not of long duration and disappear within 10 to 20 minutes. The stimulation effects upon the central nervous system are mainly due to the areca nut which contains an active principle, the volatile alkaloid called arecoline. This substance produces a state of excitation of the central nervous system, leading to the increase of the reflexes and eventually convulsions followed by paralysis. The respiration becomes more frequent and the heart is often slowed. The nervous effects may vary in different individuals and animals according to disposition. Dogs, for instance, after ingestion of areca nut exhibit extreme excitement; frogs on the other hand show symptoms of depression.

The effects may also vary according to the nuts used. Raw nuts produce vertigo and a sense of intoxication resembling that experienced after alcohol; with old nuts these effect are not clearly so marked. The variation in the effects produced is due to differences in the arecoline content of the nuts. Besides the active principle of the areca nut, the essential oil of the betel leaf also produces in animals a primary excitation followed by a kind of intoxication, it enhances the effects of areca nut and acts synergistically upon the central nervous system. In addition to the above two main ingredients, the alkaline reaction of the lime plays an important part in liberating the alkaloid arecoline from areca nut. In this way lime also plays an important role in enhancing its nervous effects.

EFFECT ON MUSCULAR OUTPUT.—Chopra and co-workers have carried out series of tests to investigate the effect of betel morsel on muscular and mental work, betel morsel with and without areca nuts in the fresh and dried state being used. There was no question of suggestion as the taste was made identical by the use of spices and flavouring agents and the subjects under test were quite unaware of difference in ingredients. The first part of the test consisted in establishing a certain degree of fatigue by riding on a bicycle along a road. Two pieces of betel morsels with different ingredients were then given; work was resumed after a rest of half an hour, and was pursued until complete exhaustion set in; the time of exhaustion was recorded in each case. The pulse rate and blood pressure were also recorded in certain cases and the general condition was noted. The total amount of work done was also noted in different cases. The pulse and the blood pressure were not much affected but it was found that the working capacity was

slightly increased by betel leaf. This was further enhanced by 10 to 15 per cent. when the morsels prepared with fresh areca nuts are used.

EFFECTS ON MENTAL EFFICIENCY.—Efficiency tests were carried out in twenty normal individuals, most of them being clerks and medical students from the Punjab, where the betel morsel is used in moderation. It would appear from these experiments that small and moderate doses of pan slightly stimulate the mental faculties, resulting in quicker solution and greater accuracy in arithmetical calculations.

PATHOLOGICAL CHANGES PRODUCED BY EXCESSIVE BETEL CHEWING.—The same authors have examined a series of 400 habitual betel chewers in this country and a brief summary of the findings is detailed in the underlying Table XVI. All these individuals were taking more than 20 morsels daily.

TABLE XVI

THE PATHOLOGICAL CHANGES AND THEIR RELATIVE FREQUENCY
IN HABITUAL INDULGERS OF PAN

Pathological Conditions.	Number of Cases.	Frequency of Percentage.
1. Caries	120	30.0
2. Deposition of black tartar	218	54.4
3. Recession of gums	82	20.5
4. Partial or complete loss of sensibility of the buccal mucosa	60	15.0
5. Pyorrhoea alveolaris	280	70.0
6. Dyspepsia	160	40.0
7. Palpitation	180	45.0
8. Neurosis	35	8.75
9. Giddiness	20	5.0
10. Slow cerebration	10	2.5

The figures given above are considerably higher than those occurring among those who do not take betel leaf habitually.

It would appear from this table that excessive indulgence in betel chewing leads to many pathological changes which are deleterious to health. Dental troubles, oral sepsis, dyspepsia, palpitation, neurosis and slow cerebration are only some of the innumerable mischiefs produced by this habit.

CANCER OF THE MOUTH.—The excessive use of betel morsel undoubtedly leads to chronic irritation of the lips, mouth and tongue and predisposes to epitheliomatous growths in susceptible individuals. According to Castellani and Chalmers, betel irritation is the commonest cause of cancer of old people in the East. Cancer of the mouth and lips was found to be more frequent in localities where the betel habit was widely prevalent, e.g., Assam, Burma and southern India, than in the northern parts of India where its use was not so popular. Out of 141 cases of cancer among chronic indulgers in pan in various hospitals of

Bengal, Bihar and Orissa, 18 were cancer of the lips, 3 cancer of tongue and 120 cancer of the rest of the body. This showed carcinomatous growths of lips and tongue comprised at least 14 per cent. of the total number of cancer cases. Betel chewing therefore definitely predisposes to carcinomatous growths of the mouth.

Milton (1946) observed that unusually high incidence of oral cancer has been observed by Australian and U.S. Army physicians among several thousand natives of New Guinea and nearby islands, where daily betel chewing is common. The chewing material consists of the Areca, catechu (betel nut) ("bue"), the leaves and pods of the piper betle plant ("daku") and lime ("kumbung") principally calcium carbonate with burnt lime obtained from sea shells or coral. The lime is employed to neutralize the astringent effect of the acid nut. Systemic effects of the mixture include exhilaration, sleeplessness and on over indulgence, ocular disturbances. A slight red color formed when the 3 ingredients are mixed in the mouth, can be reproduced *in vitro* without saliva; it also occurs when an aqueous solution of the piper leaf or pod is used instead of the whole leaf or pod, or when the lime is replaced by sufficient sodium hydroxide and does not occur when the lime is replaced by pure calcium carbonate.

SUMMARY.—The ill-effects of betel-chewing in this country were examined in over one thousand people who were habituated to its use. From the toxicological point of view the objections against its use are less serious than those against alcohol and tobacco. Taken as a whole, the ill-effects of betel are milder than those of narcotics. Dutch observers in the East Indies noticed that it was perfectly harmless in moderate amounts. One or two pan morsels a day may stimulate muscular and mental efficiency. The chief objection to its use is that once the habit is formed it is difficult to stop it. From this point of view the consumption of betel must be regarded as an evil. The withdrawal symptoms are a general sense of fatigue and exhaustion, possibly from loss of the stimulation reflex. Unpleasant taste in the mouth and disinclination for exertion are often complained of. According to Ahmed (1928) people who are habitual betel chewers become dyspeptic at about the age of 30 years and suffer from pyorrhoea alveolaris with its attendant sequelae. He was also of the opinion that cancer of the tongue and cheeks frequently occurs in those who indulge in it excessively. Modi (1928) also made similar observations and found that pyorrhoea was very frequent in these cases but dental caries was not very common. There is dulling of sensibility of the buccal mucous membrane, recession of gums, deposition of lime concretions and atrophy of the alveolar processes.

Such effects were observed by Chopra and co-workers in excessive consumers and not in moderate and occasional indulgers. Another point, which must not be lost sight of excessive consumers, is that constant stimulation of salivary secretion involves an enormous waste of saliva which is expectorated or swallowed instead of being utilized for digestive purposes. The fibrous portions of betel leaf and betel nut get into the crevices of the teeth and stay there for some time leading to the formation of pockets. This results in irritation of the gums and

inflammation of the alveolar margins and ultimately pyorrhoea alveolaris results. Another point against the use of pan is the concomitant use of zarda (an aromatic preparation containing tobacco) which is not infrequent. This irritates the buccal mucous membrane, acts on the nerve endings of the teeth, decreases their sensibility and upsets the gastro-intestinal tract.

The consumption of lime with each morsel may lead to excess of lime in the system, with its accompanying effects; lime is excreted in the saliva and is deposited on the teeth in the form of yellow tartar which, if not promptly dealt with, leads to infection of the gum. This deposit may also extend to the roots of the teeth and thus lead to the destruction of the periodontal membrane and produce pus pockets. Further the alkaline juice of the betel morsel is believed to neutralize the gastric acidity and acts as an astringent on the mucous membrane of the stomach. All these effects are observed in excessive chewers and not in moderate and occasional consumers.

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PISTACIA INTEGERRIMA Stew. (Anacardiaceæ)

VERN.—Beng.—*Kakra*; Guj.—*Kakra*; Hind.—*Kakra*; Kash.—*Dreck, Gurgu, Kakkar*; Kumaon.—*Kakra*; Mar.—*Kakra*; Punj.—*Dreck, Gurgu, Kakar, Kakkar, Kakkeran, Kakkrangche, Tanhari, Tungu*; Sans.—*Chakra, Chakrangi, Chandraspada, Ghosha, Kulingi, Natangi, Navanga, Shikhari, Vakra, Vanamurdhaja, Vishanika*; Urdu.—*Kakra*.

It is a tall tree commonly met with in the sub-Alpine Himalayas. On the leaves and petioles of this plant are found peculiar gall-like excrescences, which give the appearance of 'horns' from a distance. These 'galls' are formed by a kind of insect (aphis). The galls vary in size; the external surface is of a pale greenish brown colour and has a fimbriated appearance. On breaking open the galls, a reddish inner surface is seen and appears to be covered with particles of dust which, on microscopical examination, is found to be the debris of the insects and their excretory matter. The taste of the powdered galls is very astringent and slightly bitter and they have a terebinthine odour. They have long held a place in the Hindu Materia Medica as a useful remedy in cough, phthisis, asthma, etc. The usual dose is 20 grains combined with demulcents and aromatics. The Mohammedan writers consider it useful in pulmonary affections and in diarrhoea and vomiting. European writers also mention the drug but say nothing about its properties.

CHEMICAL COMPOSITION.—Little work has previously been done on the chemistry of this drug. A chemical examination indicates chiefly the presence of the following substances: essential oil 1.21 per cent., crystalline hydrocarbon 3.4 per cent., tannin substances 60.0 per cent., and gum mastic 5.0 per cent. The essential oil was obtained by steam distillation of the coarsely powdered drug. The essential oil is of a pale greenish yellow colour with a turpentine-like odour and taste. The specific gravity of the oil is 0.8885 at 15°C. A crystalline principle was obtained by treating the alcoholic extract with light petroleum ether, distilling off the ether and treating the residue with absolute alcohol. This on concentration deposited large transparent prismatic crystals. The substance is insoluble in water, soluble in nearly all the organic solvents, is tasteless and has a sharp melting point of 146°C. The tannins present are of a yellowish crystalline appearance and can be obtained from an aqueous solution of the drug by precipitating with lead acetate, and decomposing the precipitate in suspension in water with sulphuretted hydrogen, concentrating and drying. An estimation of the tannins showed their amount to be nearly 60 per cent. in an air-dried sample of the drug. After removing the essential oil and the crystalline hydrocarbon by means of petroleum ether from an alcoholic extract of the drug, dissolving the residue in alcohol and pouring it in cold water, the insoluble resin can be precipitated, while the tannins remain in the solution. By repeating the above process the resin can be obtained in a fairly pure condition. Its chemical behaviour is identical with that of gum mastic. No substance of the nature of an alkaloid or glycoside could be detected.

Ghose (1945) extracted the galls with benzene and obtained two acids, acid A needle-shaped compound, m.p. 179-80°C., acid B was in hard rhombic crystals, m.p. 161-62°C. Both were presumed to be, $C_{30}H_{44}O_3$, belonging to the triterpinoid carboxylic acids. Karimullah (1945) extracted the galls with ether and obtained two crystalline products melting at 179-80°C., and 163°C. The galls on steam distillation yielded 1.3 per cent. of essential oil which has specific gravity 0.8759 (13°C) n_D^{18} 1.4735. The oil contains *l*-pinene (25 per cent.), camphene (27 per cent.), *dl*-limonene (4.5 per cent.), cineol (10 per cent.), *l*-terpeneol (20 per cent.), and aromadendrene (4 to 5 per cent.). In addition to these the oil contains a small percentage of a lactonic stearoptene and caprylic acid to the extent of 15 per cent. Deshpande and Baslas (1950) investigated the plant and the essential oil obtained from it was found to consist of 95 per cent. of *dl*-pinene as the chief component.

The drug has a great reputation both in the Hindu and the Mohammedan medicine as a tonic and expectorant, and it is useful in asthma, phthisis and other conditions of the respiratory tract. Its use in pulmonary affections is no doubt due to the presence of a fair amount of essential oil, while the large amount of tannins present in the drug acts as a strong astringent. On the whole we found that the importance of the drug was very much overrated. It may be classed with the terebinthinate astringents. This drug appears to have no advantage over many of the stronger expectorants in the British Pharmacopoeia and its antiseptic action is not of a higher order.

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PLANTAGO OVATA Forsk. (Plantaginaceæ)

ISPAGHULA; SPOGEL SEEDS

VERN.—Arab.—*Bazrekatima*, *Bazrequatuna*; Beng.—*Eshopgol*, *Isabgul*, *Ispaghul*; Bomb.—*Isapghol*; Guj.—*Isafghol*, *Isapghol*, *Urthamujiru*; Hind.—*Isabghul*, *Isbaghol*, *Ispaghul*, *Issufgul*; Kash.—*Ismogul*; Mal.—*Karkatasringi*; Mar.—*Isabagola*; N.W.P.—*Ispaghul*; Pers.—*Isabghul*, *Isparzah*, *Ispoghul*; Punj.—*Bartang*, *Isabghol*, *Isafghol*, *Ispaghul*; Sans.—*Ishadgola*, *Shlakshnajira*, *Snigdhajira*, *Snigdhajiraka*; Tam.—*Ishappukol*, *Iskol*, *Ispoghul*; Tel.—*Isapagala*, *Isphagula*; Urdu.—*Ispaghul*.

The genus *Plantago* comprises about 50 species, of which ten are natives of India. A number of these herbs have been used in the indigenous medicine for many centuries. This herb is found growing in the plains of the Punjab and Sind and low hills from the Sutlej westward; it is also cultivated to a small extent in different parts of India, such as Bengal, Mysore and the Coromandel coast. Westward it is also distributed to Spain and the Canaries.

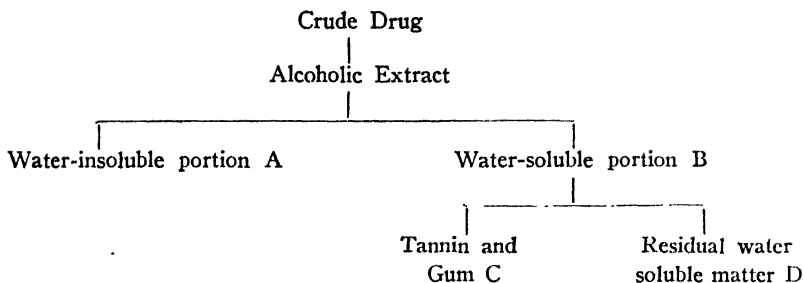
The seeds of this plant are boat-shaped, about 1/8 in. long and rather less than 1/16 in. broad. They are translucent and pinkish grey but the colour may vary, some being brown, while others are white with a pinkish tinge, the latter being generally preferred. The concave side of the seeds is covered with a thin white membrane. When microscopically examined the epidermis of the seeds is found to be composed of polyhedral cells, the walls of which are thickened by secondary deposit, which are the source of the mucilage. Between it and the albumin is a thin brownish layer; the albumin is formed of thick-walled cells which contain granular matter. When soaked in water the seeds become enormously swollen with an abundant coating of adhering mucilage which is free from taste and odour.

The seeds of several other species of the same genus exhibit similar properties. *P. amplexicaulis* is a plant which grows in the plains of the Punjab, Malwa and Sind, extending to southern Europe. It furnishes the brown *Ispaghula* which is not infrequently met with in the Indian bazars. These seeds have also a boat-shaped appearance like those of *P. ovata* but are rather large, averaging 1/6 in. in length. They produce mucilage in the same way and probably have just as effective demulcent properties as the true *P. ovata* seeds. Large quantities of these seeds are imported into India from Persia. *P. major*, known as 'luhuriya' in Hindi and 'bartang' or 'barhang' in Persian, is a large herb which is found on the Alpine Himalayas from Peshawar and Kashmir to Bhutan at a height of 2,000 to 8,000 ft. above the sea level, as well as in Western Tibet at an altitude of 10,000 to 12,000 ft. It has also been reported to grow in Assam, Khasia Hills, Burma, Malacca, Singapore, Bombay, the Nilgiri Hills and the higher parts of Sudan. This plant was used in the ancient Roman and Grecian medicine. The seeds of *P. major* are imported largely into India from Persia and have the same properties as those of *P. ovata*. They are at the present time largely used in the indigenous medicine in India as a remedy for dysentery. The seeds are oblong and brown, marked with waves having slightly elevated longitudinal ridges of a dark colour. One side of the seed is arched and the other side is concave and marked with a scar showing the attachment to the ovary. They are insipid and have an oily taste when crushed. When soaked in water they become coated with a thick layer of transparent mucilage resembling *P. ovata*. Some of the other species of *Plantago* are *P. psyllium* (which is practically the same as *P. major*), *P. brachyphylla* and *P. lanceolata*.

USES IN THE INDIGENOUS MEDICINE.—*P. ovata* seeds are not mentioned by the writers of the Hindu medicine and appear to have been unknown to them. They, along with the seeds of several other species of *Plantago*, were very frequently referred to by Arabian and Persian writers who esteemed them very greatly as medicinal agents. Even as far back as the 10th century the Persian physician Alhervi mentioned them and a little later Avicenna referred to this drug. All the subsequent writers on Mohammedan medicine have extolled the properties of 'ispaghula'. The seeds were introduced in the Indian medicine by the advent of the Mohammedans and they began to be largely used as a popular remedy in chronic dysentery and intestinal fluxes. Even at the present time they are perhaps the most extensively used remedies for intestinal conditions. For any kind of diarrhoea, especially when blood or mucus is present in stools, it is a popular household remedy. The seeds are also considered to be cooling and demulcent and besides diarrhoea, dysentery and other inflammatory and functional derangements of the digestive organs they are also recommended in febrile conditions. They are said to have diuretic properties and are given in affections of the kidneys, bladder and urethra (gonorrhoea) in doses of 2 to 3 dr. either mixed with sugar or in the form of a decoction. Powdered seeds are frequently mixed with seeds of *H. antidysenterica* and are given in dysentery. The crushed seeds are made into a poultice and are applied to rheumatic and glandular swellings. A cooling lotion for the head is also prepared from the mucilage; and a decoction of the seeds is prescribed in coughs and colds. A slight degree of astringency is believed to be imparted to the seeds by heating them in the dry condition. *P. ovata* seeds are frequently mixed with seeds of *Salvia aegyptiaca* (V.—*Tukhm malanga*), which also grows in the plains of the Punjab and like *P. ovata* seeds yield copious mucilage.

CHEMICAL COMPOSITION.—The seeds contain a fatty oil, albuminous matter and mucilage in such large quantities that 1 part of the seeds with 20 parts of water forms a tasteless jelly within a short time. On addition of a large quantity of water and filtering, little mucilage passes, but the major part of it remains adherent to the seeds. The mucilage can be separated by straining with pressure. It is neutral in reaction, is not altered by adding or precipitated by boiling with alcohol nor is it changed by iodine, borax or perchloride of iron. It is only sparingly soluble in water. A glycoside named *aucubin*, $C_{13}H_{19}O_8 \cdot H_2O$, has been isolated from the seeds, leaves, roots and flowering stems of *P. major* and *P. media* and also from the leaves, roots and seeds of *P. lanceolata*. It crystallises in the form of colourless bush-forming needles which have a melting point of $181^{\circ}C.$, and a rotation in aqueous solution of -164.9° . This glycoside has also been found in *Ocuba japonica* and probably occurs in some of the other plants belonging to the Plantaginaceæ family.

Henry and Brown (1924) examined a number of reputed remedies used against amoebic dysentery. *Mansonio ovata* and *Rhyncosia adenodes* are used in South Africa; *Brucea abyssinica* and *B. sumatrana* are used in Abyssinia and Malaya respectively. These four drugs were examined chemically without showing any active constituents to which their amoebicidal action could be attributed. From *M. ovata* a substance called 'entericin' was isolated, but this is an ill-defined substance. From the two species of *brucea* amorphous bitter substances were isolated, but trials on the free-living protozoa showed them to be quite inactive either alone or in presence of alkali. *R. adenodes* showed no active substance. These investigators tried to combine the biological and chemical methods in the hope of being able to select some from the large number of such available drugs which seemed promising enough for detailed examination. The finely-ground drug was exhausted with boiling alcohol, the extract concentrated *in vacuo* and the thick syrup diluted with water to precipitate fatty and resinous matters, which formed preparation A. The liquor from this precipitate, after further concentration *in vacuo* to remove all the alcohol, constituted preparation B. The latter was then treated with lead acetate to remove tannin and gum, which after recovery from the lead precipitate, gave preparation C; and the residual liquor, after removing the excess of lead, yielded preparation D.



All these four fractions were carefully examined and their action tested in protozoa. None of them possesses any great degree of toxicity to these organisms.

PHARMACOLOGICAL ACTION.—The author (1930) confirmed the presence of a body of the nature of a glycoside in small quantities in the seeds of *P. ovata*; this was pharmacologically inactive and was very difficult to obtain in a pure condition. No other physiologically active substance was found; the tannins which are present in appreciable quantities have very little action on protozoa or bacteria. The efficiency of the drug would appear to be entirely due to large quantities of the mucilage. This gelatinous substance was, therefore, carefully examined. It has a jelly-like consistency and is acted on by the digestive enzymes to a very slight extent, especially when it is on the seeds. Even after incubation for 24 hours with salivary enzymes, pepsin and hydrochloric acid and the pancreatic enzymes there was very little digestion of the mucilage. It thus passes through the small intestine unchanged and during its passage it lines the mucous membrane acting as a demulcent and a lubricant. Further, the mucilage is not acted on by the intestinal bacteria in the large gut. Its presence there in fact would appear to have an inhibitory action on the growth of the organisms.

The action of such organisms as *B. shiga*, *I. flexner*, *B. cholera*, *B. coli* and bacteria from whole stool, was tested on the mucilage by putting it in broth cultures in which these organisms were grown. The tubes were put in an incubator and even after a fortnight still remained unaffected. That the mucilage does not form a good media for the growth of intestinal organism is shown by the fact that if it is allowed to set in a petri dish and the surface is plated with the culture of such organisms as *B. shiga*, *B. flexner*, *B. coli* and other foecal organisms, no colonies are found to grow. It has also been shown that if a thin layer of the mucilage is spread on the surface of agar media inoculated with *B. shiga*, *B. flexner*, etc., the growth of these organisms is greatly inhibited.

That the mucilage is not acted on to any great extent by the digestive enzymes in the small intestine or the bacteria in the large intestine is further shown by the fact that large quantities of it can be seen in the stool after administration of the seeds. The author gave a dessert spoonful of the powdered seeds to cats with a stomach tube. On opening up the intestine on the following day, the whole of the mucilage was found spread on the surface of the mucous membrane of the small and the large intestines. In the latter where the contents had assumed a solid form, both the mucilage and seeds were on the surface of the mucous membrane

forming a layer between the solid faeces and the surface of the mucosa. From these experiments it is clear that the mucilage forms a coating over the surface of the ulcers. This would not only protect the injured mucosa from the irritating products of gastro-intestinal digestion but would also prevent access of the motile bacteria which would be entangled in the meshes of the gel.

The mucilage further being of colloidal nature has a remarkable power of absorbing bacterial and other toxins. Our experiments *in vitro* have shown the jelly-like mucilage from *P. ovata* seeds is very active in this respect.

THERAPEUTIC USES.—The seeds were noticed early by the Western practitioners and eventually found their way into the Indian Pharmacopoeia in 1868. In the early part of the eighteenth century, Fleming, Ainslie and Roxburgh all spoke favourably regarding their value in diarrhoeic conditions. Since then they have been very extensively tried by many Western practitioners who have confirmed the opinion that they are useful in chronic dysentery and diarrhoea. Some clinicians have combined the seeds with ipecacuanha treatment. They are said to be very useful in all inflammatory affections of the mucous membrane of the alimentary canal on account of their emollient, demulcent and laxative properties.

For the past 15 years the present writer has given very extensive trials to the seeds of *P. ovata* in the following conditions with excellent results:

(1) *Chronic Bacillary Dysentery.*—This condition is invariably associated with the presence of mucus in the stools. According to Acton and Knowles (1928), the commonest type of chronic bacillary dysentery in India is due to infection with Flexner's bacillus, next comes Strong's bacillus and lastly Shiga's bacillus. Some of the chronic diarrhoeas in the tropics are due to Morgan's bacillus or the para-dysentery group. The bowel in these conditions is generally ulcerated and the toxins absorbed from the ulcerated surface produce a diminution of tone of involuntary muscle of the gut wall producing intestinal stasis, visceroptosis and a general toxæmic condition in the individual. Chronic diarrhoea with painful peristalsis persists for prolonged periods and may alternate with periods of constipation. The condition is intractable and may persist for years.

(2) *Chronic Amoebic Dysentery.*—These patients may have constipation or irregularity of bowels and the large majority show mucus in their stools. The degree of ulceration varies greatly according to the intensity of the intestinal symptoms. There are two types of these patients—the lean, thin, neurasthenic type who suffer from habitual constipation or constipation alternating with diarrhoea, or the fat, jovial type who suffer from chronic morning diarrhoea.

(3) *Chronic Constipation with Auto-intoxication Produced from Other Causes.*—In the first two conditions the administration of the seeds gives a considerable relief to the patient. It has already been stated that the seeds do not contain any active principles having any marked toxic effect on the bacteria or protozoa. There are small quantities of tannins present, but their effect in this respect is very slight indeed. The whole action of the drug appears to be entirely mechanical. The irritated or ulcerated surface of the intestinal mucosa are soothed

by the demulcent action of the mucilage which covers the surface and in this way prevents it from coming in contact with irritating products of digestion of food-stuffs, intestinal juices and gases which are always present in the intestine and which irritate the parts and prevent the ulcers from healing. Exclusion of these factors enables the ulcers to heal and inflammation of the mucosa subsides. Further, the absorption of toxins, which takes place rapidly from the ulcerated surface, is prevented by a coating of the mucilage which being of a colloidal nature, adsorbs the toxins from the gut and thus helps in excreting them from the body. As the jelly-like mass is not quickly acted on by the gastro-intestinal juices and bacteria, practically the whole of it is available, and passes out in the stool carrying with it the adsorbed toxins in the course of the next 12 hours. In this way the patient not only gets relief of the pain, tenderness or discomfort in the abdomen but his general condition is also improved owing to decrease in the absorption of toxins. In chronic amoebic dysentery which has failed to react to intensive courses of emetine or the kurchi alkaloid, the author has tried prolonged courses of liquid extract of kurchi (*H. antidysenterica*) and ispaghula with success. The patient is put on 2 dr. of the extract, 3 or 4 times a day, at the same time he takes 2 or 3 heaped dessert-spoonfuls of the seeds twice daily, the treatment being continued for six weeks or two months. Not only is there considerable relief to the symptoms but examination of the stools shows disappearance of *E. histolytica*.

In chronic amoebic dysentery where constipation is one of the main symptoms, the mucilage covers the faeces as they become solid in the large intestine and thus facilitates their passage through the large gut by acting as a lubricant. In this condition as well as in chronic spastic constipation its action may be aided by giving small doses of saline purgatives.

(4) *Hill Diarrhoea*.—This condition is not infrequently met with in people who go up to the hills and is more common Europeans. The patient usually passes several stools in the morning and the condition is accompanied by catarrh of intestine. *P. ovata* seeds are particularly useful in the early stages. Not only is the irritated mucous membrane soothed and protected by the mucilage, but the fermentation is also inhibited and the stools assume a solid form.

(5) *Chronic Diarrhoea in Children is also Considerably Benefited*.—Most of these conditions are due to irritation of the gut with bacterial toxins and the mucilage acts by removing this irritation.

DOSAGE AND MODES OF ADMINISTRATION OF *P. OVATA* SEEDS.—The seeds are thoroughly cleaned from sand and grit and other extraneous matter with which they are always found mixed in commerce. This can be done by sifting them through a fine sieve or mosquito-netting and picking out anything which still remains with the fingers. Before the seeds are taken they should be quickly washed once or twice in a cupful of water. The usual dose recommended is 2 to 4 dr., but considerably larger quantities, i.e., 1 to 2 oz., may be given with advantage. Two to three heaped dessert-spoonfuls of the seeds or more if

necessary may be given 2 or 3 times a day. They contain no toxic principles of any kind and most of them pass out of the gastro-intestinal tract in 6 to 12 hours. In fact in some cases, especially when constipation is present, larger doses are essential as their action is produced partly by the lubricating action of the mucilage and partly by the increase in the bulk of the intestinal contents which mechanically stimulates the intestinal peristalsis. Four methods are recommended for the administration of the seeds:

(1) The clean, dry seeds are put in a cupful of water and after a preliminary washing, 1 or 2 teaspoonfuls of sugar is added if desired. The mixture is stirred and taken.

(2) The seeds are added to a cupful of water and are allowed to stand for 20 to 30 minutes till all the mucilage comes out. If desired some sugar is added and the mucilaginous mass is then swallowed.

(3) A mucilaginous decoction is prepared by boiling the required quantity of the seeds in a couple of pints of water till the quantity is reduced to about half. This is then taken divided into doses of 2 to 4 oz. and taken every 2 or 3 hours. It has already been pointed out that the mucilage is not altered by boiling.

(4) The mucilage-containing cover of the seeds is separated from the seeds by crushing them and separating the husk by winnowing. One to two teaspoonfuls of it are given in a cupful of water with a little sugar. By many indigenous practitioners this preparation is preferred to whole seeds, especially in acute conditions of the gastro-intestinal tract.

The author prefers the first method in ordinary chronic forms of dysentery and diarrhoea as it allows the seeds to mix thoroughly with the intestinal contents and in this way enables them to spread over the whole of the surface of the mucous membrane evenly. If the mucilage is allowed to form outside, it conglomerates into sticky masses and is not evenly distributed and passes out of the intestine in lumps. It has been shown by experiments *in vitro* that the digestive enzymes have a weaker action on the mucilage when it is on the seeds. When a decoction is made and the mucilage is separated, it is partly changed by the digestive enzymes into a non-mucilaginous substance after incubation for 24 hours, whereas that on the seeds is little altered. This supports the superior action of the whole seeds. The decoction and mucilage-containing cover separated from the seeds is, however, preferable in sub-acute types of dysenteries both of protozoal and bacillary origin. The drug has the advantage of being tasteless, in fact with sugar it is quite pleasant to take. It is therefore not objectionable to take and is very suitable for children.

Various preparations of paraffin are being used as intestinal lubricants. They enter the caecum mixed with the iliac contents and keep the contents of the large gut soft. In addition they accelerate the passage of faeces through the large intestine which consequently does not become overloaded. Paraffin being a mineral product is not absorbed and practically the whole of it can be recovered from the stools. A perusal of what has been said about the mucilage of *P. ovata* seeds will show that it acts in very much the same way as liquid paraffin does so far as its lubricant and constipation-relieving effects are concerned. It is further free from many disadvantages which liquid paraffin possesses. It is well-known that even the best preparations of paraffin are not free from producing irritant effects and many cases of malignant disease of the large gut

have been attributed to its long-continued use. Eczema ani does not uncommonly occur in persons habituated to its use and 'paraffin pains' are not of very rare occurrence. It has also been stated that long-continued use of liquid paraffin may prevent absorption of nutrient material from the intestines by forming a thin impermeable coating round the intestinal villi and cases of malnutrition have been recorded after its prolonged use. *P.ovata* mucilage is a vegetable product and is free from all these disadvantages, besides being very much cheaper. Two or three dessert-spoonfuls taken at bed time produce the same laxative effects as liquid paraffin.

SUMMARY.—The seeds of *P.ovata* are very beneficial in chronic dysenteries of amoebic and bacillary origin and chronic diarrhoeas due to irritative conditions of the gastro-intestinal tract. A glycoside named *aucubin* has been found in the seeds but it is physiologically inactive. The tannins which are present in appreciable quantities have little action on the entamoebae or bacteria. The action of the drug would appear to be purely mechanical, being due to the large amount of mucilage which is contained in the superficial layers of the seeds. This mucilage is shown not to be acted on by the digestive enzymes passes through the small intestine unchanged. It lines the mucous membrane of this part of the gut and its demulcent properties give it a protective and sedative action. In the large gut the intestinal bacteria have been shown to have little or no action on the mucilage. Practically the whole of it is passed out unchanged during the 12 to 24 hours following its administration. During its passage through the gut it coats the inflamed and ulcerated mucosa and protects it from being irritated by the fluids and gases, the products of gastro-intestinal and bacterial digestion. This enables the lesions to heal quickly. The toxins present in the gut are further absorbed by the gel and their absorption into the system is prevented. The seeds are taken in large quantities and as they swell up in contact with water they increase the bulk of the intestinal contents and in this way relieve chronic constipation by mechanically stimulating the intestinal peristalsis. The mucilage of *P.ovata* seeds acts in very much the same way as liquid paraffin. It is very much cheaper and is further free from the injurious effects produced by the habitual use of the latter drug, *i.e.* malignant disease of the colon, eczema ani, paraffin pains, etc.

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PLUMBAGO ROSEA Linn. (Plumbaginaceæ)

VERN.—Arab.—*Shittermul*, *Shitarajehmar*, *Shitturridge*; Beng.—*Chitra*, *Lalchita*, *Raktochita*, *Raktochitra*; Bomb.—*Lal chitra*; C. P.—*Chitrak*; Eng.—*Fire plant*, *Official leadwort*, *Rosy flowered leadwort*; Hind.—*Chitra*, *Lalchita*, *Lalchitarak*, *Lal chitra*, *Raktachitra*; Kash.—*Shitranj*, *Shitray*; Mal.—*Chettikotuveli*, *Chuvannakotuveli*; Mar.—*Lalchitra*; Pers.—*Shitrakesurkh*; Sans.—*Agni*, *Atidipyā*, *Chitraka*,

Chitranga, Chitravalli, Dahaka, Dipika, Hrasvagni, Kalamula, Marjara, Pathi, Raktasikha, Usharbudhavahvaya, Vyala; Tam.—Akkini, Sengodiveli, Sittiramulam; Tel.—Errachitramulam.

It is a shrubby perennial, frequently cultivated in gardens in India. The root is mentioned by ancient writers as an abortifacient and vesicant. The bruised root in its natural state is acrid and stimulating but when tempered with a little bland oil, it is used as an external application in rheumatic affections of joints and paralytic conditions. It is given internally in small doses for the same complaints in combination with other drugs. It has also been recommended as an efficient substitute as counter irritant for producing blisters in place of cantharides.

CHEMICAL COMPOSITION.—Roy and Dutt (1928) isolated plumbagin, the active principle of the root by extracting them with petroleum ether, b.p. 70-90°. It was obtained in form of golden yellow needles, m.p. 77-78°C, after several recrystallisation from dilute alcohol. The root bark of the plant was examined by Tummin Katti and Patwardhan (1932) and was found to contain plumbagin, a large amount of amorphous brown pigment and a reducing sugar but no substance of alkaloidal nature. The powdered root bark (33 kg.) was thoroughly extracted with 90 per cent. alcohol. After removing the greater part of the solvent the syrup was mixed with 2 kg. of the alcohol extracted material, dried completely and was then successfully extracted in a specially devised continuous extraction apparatus with petroleum ether, ether, chloroform, methyl alcohol and ethyl alcohol. The residue from the petroleum ether extraction was dissolved in ether and this solution by treatment with 3 per cent. sodium hydroxide followed by saponification with alcoholic sodium hydroxide yielded sitosterol, a fatty alcohol probably arachidyl alcohol, oleic, linoleic and lignoceric acids in addition to plumbagin. The ether extract showed the presence of sitosterol, glycoside, $C_{33}H_{56}O_6$, m.p. 259-60°C. and a saturated hydrocarbon, m.p. 77-78°C. Glucose and Tannin were detected in the ethyl alcoholic extract. The chloroform, ethylacetate extractives contained chiefly a water insoluble brown amorphous powder. Purification of plumbagin by steam distillation gave plumbagin, $C_{11}H_8O_3$, in orange yellow silky needles, m.p. 75-76°C. Plumbagin has an irritating odour and acts on the mucous membranes chiefly of the respiratory tract. Its M.L.D. is 110-20, 20 and 30 mg. per kg. body weight for albino rats, guinea pigs and frogs respectively.

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PLUMBAGO ZEYLANICA Linn. (Plumbaginaceæ)

VERN.—Arab.—*Shitaraj*; Beng.—*Chita, Chitruk, Sufaid*; Bomb.—*Chitra, Chitrack*; Eng.—*Ceylon leadwort, White-flowered leadwort*; Hind.—*Chita, Chitarak, Chitawar, Chiti, Chitra*; Mal.—*Tumpukotuveli*; Mar.—*Chitraka, Chitramula*; Nepal.—*Chitu*; Pers.—*Bighbarindeh, Shitarak, Shitirak*; Punj.—*Chitrak*; Sans.—*Agni, Agnimata, Agnisikha, Anala, Analanama, Barhi, Bhali, Chitraka, Chitranga, Daruna, Himarati, Hutabhuk, Jataveda, Krishnavartma, Kuta, Shushma, Ushana, Vallari, Vanhi, Vanhinama, Vyala*; Tam.—*Adigarradi, Akkini, Kanilam, Sittragam, Sittramular, Vanama, Vengodiveli*; Tel.—*Agnimata, Chitramulamu, Tellachitramulamu*; Urdu.—*Chitalakri.*

P. zeylanica is an allied species and is considered to be a cultivated variety of *P. rosea*. The root of these plants has been quite well-known in our country for a very long time and there are references to it in the classical works of Charaka, Susruta etc. It is believed to increase the digestive powers, it promotes the appetite and is said to be useful in dyspepsia, piles, anasarca, skin diseases, etc. As a local application, the root was held in high esteem and it entered into the composition of several caustic preparations. The roots have been largely used as abortifacients in the indigenous practice. With this object it is sometimes given internally but more commonly it is employed as a local irritant to the *os uteri*. It is also used as an irritant to the skin by malingerers or to support false charges.

CHEMICAL COMPOSITION.—Dulong (1885) first isolated an active principle from the root of Plumbago and named it 'plumbagin'. Flückiger (1889) isolated the same substance in a slightly purer form from the root of *P. zeylanica* by submitting it to steam distillation and extracting the distillate with ether. Roy and Dutt (1928) have found that plumbagin is present in all the varieties of plumbago met with in India to a maximum of about 0.91 per cent. The proportion of plumbagin varies within wide limits according to the locality, growth, age, condition of the soil and season of the year. In general it is found by these workers, that the older the plant and the drier the soil, the greater is the quantity of active principle found in the roots. It has also been found that fresh roots yield a much greater proportions of plumbagin than roots which have been stored for a considerable time.

PHARMACOLOGICAL ACTION.—Keien Ko (1931) studied the pharmacological action of plumbagin. He finds that it stimulates the central nervous system in small doses while with larger doses, paralysis sets in leading ultimately to death. The blood pressure shows a slight fall. The stimulant action is not properly observed in the isolated heart of the frog. The peripheral vessels are found to dilate. Small doses stimulate the plain muscle all over the body, but large doses produce immediate paralysis. The minimum lethal dose has been found to be 0.5 mg. per gm. of frogs, 0.1 mg. per gm. of mice and 10 mg. per kilo. of rabbits. Bhatia and Lal found that plumbagin is a powerful irritant and has well marked antiseptic properties. In small doses, the drug is a sudorific; large doses causes death from respiratory failure. The action is probably due to the direct effect of the drug on the muscles.

THERAPEUTIC USES.—As plumbagin is a potent remedy it is likely to be of use in therapeutics if its dosage is properly regulated by proper pharmacological studies. Owing to its property of setting up irritation of the skin, it may be of use in chronic skin diseases and in leucoderma. Vyas and Lal have got fairly good results from its use in early cases of leucoderma and baldness of the head but further work is necessary.

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PONGAMIA GLABRA Vent. (Leguminosæ)

VERN.—Arab.—*Aktemakat*; Beng.—*Dahur karanja*, *Dalkaramcha*, *Karmuj*, *Khawari*; Bomb.—*Karanj*, *Kiramal*; C. P.—*Kurunji*; Eng.—*Indian beech*; Hind.—*Kanja*, *Karanjaka*, *Kiramal*, *Papar*; Kumaon.—*Paper*, *Sukhchain*; Mal.—*Minnari*, *Punnu*, *Unnu*; Pers.—*Khaiulmalisa*; Punj.—*Karanj*, *Paphri*, *Sukhchein*; Sans.—*Angaravalli*, *Badhaphala*, *Chirabikva*, *Dhana*, *Naktamala*, *Prakirya*, *Putika*, *Purikaranja*, *Snigdhapatra*, *Tapasvi*, *Vrittaparna*; Tam.—*Agirunanandam*, *Ilanji*, *Kolliyam*, *Naguttam*, *Ponga*, *Udagu*; Urdu.—*Karanjwah*.

P. glabra is one of the commonest trees in India especially near the coast, and is met with from the central and eastern Himalayas to Ceylon. It is a small handsome tree with glabrous, bright green foliage. The seeds, leaves and the oil derived from the seeds are all used in Hindu medicine as remedies for skin diseases and rheumatism. A bath prepared from the leaves is used for relieving rheumatic pains and the juice of the root is used for cleansing foul ulcers and sores. The oil is held in high esteem as an application in scabies, herpes and other cutaneous diseases. Internally, the oil has sometimes been used as a stomachic and cholagogue in cases of dyspepsia with sluggish liver. The powdered seeds of *P. glabra* are supposed to be of value as a febrifuge and tonic in asthenic and debilitating conditions. They are also used very commonly for their expectorant properties in bronchitis and whooping cough.

CHEMICAL COMPOSITION.—The seeds contain 27 to 36.4 per cent. of a bitter fatty oil (Pangamol or Hongay oil). The oil is brown in colour and has a characteristic odour. The colour can be largely removed by treatment with alkali and the odour by treatment with superheated steam under reduced pressure. The fatty acids present in the oil include myristic 0.23, palmitic 6.06, stearic 2.19, arachidic 4.30, lignoceric 3.22, dihydroxystearic 4.36, linolenic 0.40, linolic 9.72 and oleic acid 61.30 per cent. Bechenic acid which occurs free in the oil and is very likely removed during the process of purification, together with 3.56 per cent. of unsaponifiable matter. Investigations carried on in the Department of Chemistry at the School of Tropical Medicine show that, besides the fixed oil, the seeds contain traces of an essential oil. Nearly 250 gm. of the powdered seeds were distilled in steam and only a trace of an essential oil was obtained.

Seshadri and co-workers (1942) investigated the pongamia oil and isolated a crystalline compound Karanjin and another crystalline substance pongamol, m.p. 128–9°C. Working with the flowers, they found that the ligroin extract of the flowers of *P. glabra* was made up of aliphatic waxy matter, some oil and a small amount of pongamin. The aliphatic waxy portion consisted mostly of esters derived from C₂₄ to C₃₀ alcohols and C₂₄ to C₃₀ acids and smaller amounts (12 per cent.) of hydrocarbons of C₂₇ to C₃₃. Pongamin is a colourless crystalline substance, m.p. 212°C and having the approximate formula, C₁₅H₁₂O₅. Its properties resemble those of karanjin. The ether extract contained much free kaemferol and small amount of resitosterol occurring probably as an ester. The alcoholic extract contained small amounts of a sterolin, m.p. 262°C., and was found to be resitosterol glycoside. Larger amounts of neoglabin and glabrosaponin were found. The former is a high melting complex amino acid which is sweet in taste and resembles glabin to a considerable extent. The glabrosaponin seems to have the formula, C₅₀H₈₄O₂₈, it is a complex glycoside of a triterpenoid saponenin group having the probable formula C₃₀H₅₀O₆. They also investigated the roots and isolated a new crystalline compound Kanugin, C₁₉H₁₈O₇, m.p. 197–8°C. From

the cake of the seeds they isolated a crystalline nitrogenous substance glabrine, $C_{21}H_{42}O_{12}N_3$, m.p. $290^{\circ}C$. (dec.) in 0.1 per cent., yield. It has no marked physiological properties.

PHARMACOLOGICAL ACTION AND THERAPEUTIC USES.—The finding of an essential oil in the seeds of *P. glabra* is significant and in view of the popularity of the seeds in certain districts as a remedy for troublesome cough, it was thought that the essential oil present in the seeds might have some part to play in the therapeutic efficacy of the drug. A portion of the steam distillate containing the essential oil was, therefore, passed through the pharmacological tests to find out the nature of the action of the oil. The steam distillate, on intravenous injections in experimental animals, is found to cause a slight rise in blood pressure which is of a transient nature. The bronchioles appear to be slightly relaxed. Further work is in progress.

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PREMNA INTEGRIFOLIA Linn. (Verbenaceæ)

VERN.—Beng.—*Bhutbhiravi*, *Ganiari*; Bomb.—*Arni*, *Narvel*; Hind.—*Agetha*, *Arni*, *Ustabunda*; Mal.—*Munna*; Mar.—*Aran*, *Chamari*, *Kharanarvel*; Sans.—*Agnibijaka*, *Agnimanthā*, *Ananta*, *Araniketū*, *Havirmantha*, *Jayanti*, *Jyotishka*, *Mathana*, *Nadcyi*, *Pittamata*, *Tanutvaka*, *Tejomantha*, *Vaijayantika*, *Vanhimanthā*, *Vanhimula*; Tam.—*Munnai*, *Pasumunnai*; Tel.—*Gabbunelli*, *Karnika*, *Nagura*, *Tukkadu*; Urdu.—*Arani*.

It is a small tree or a big shrub which grows near the sea from Bombay to Malacca; it also grows in Ceylon. The drug is very extensively used in Ayurvedic medicine, the roots being considered as laxative and stomachic. The decoction of the root is given in gonorrhoea and during convalescence from fevers. It is an important ingredient of "Dashamula" a favourite decoction of ten plants often prescribed by the practitioners of indigenous medicine in obstinate fevers. A soup made from the leaves is occasionally used as stomachic and carminative. The root is also given as a cordial tonic. The whole plant in form of decoction is used in rheumatism and neuralgia.

CHEMICAL COMPOSITION.—Dymock, Warden and Hooper report the presence of an amorphous alkaloid, a substance reducing Fehling's solution and an astringent body giving a green colour with ferric chloride but no precipitate with gelatin. Basu and co-workers (1947) isolated from the stem bark of the plant three alkaloids premnine, ganiarine, ganikarine and some unsaturated aromatic hydrocarbons of high molecular weight. Premnine, $C_{14}H_{15}ON$, m.p. $82^{\circ}C$., was obtained in an amorphous form; ganiarine could only be isolated in crude form, ganikarine, $C_{19}H_{47}NO$, m.p. $230-32^{\circ}C$. was also obtained in an amorphous form.

PHARMACOLOGICAL ACTION.—The pharmacological action of the alkaloids on the blood vessels was studied by determining the rate of perfusion in the frog.

It was found that ganikarine has no action, whereas the ganiarine and premnine raise the blood pressure by contracting the blood vessels, i.e., they have a sympathomimetic action. Premnine on instillation into the eye of the frog and puppy produced dilation of the pupil in concentration of 1 in 10,000. Further work on this plant is desirable in view of the fact that an alkaloid with powerful sympathomimetic action is present.

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PRISTIMERA INDICA Willd. (Hippocrateaceæ)

Syn. *Hippocratea indica* Willd.

It is a robust climber growing wild in the forests extending from Konkan in the south to Madras, Bengal and Assam in the east. The plant is a rambling or scandent shrub with a bushy habit. The plant is extensively used in Kanara. It is commonly believed by the people of that locality that a teaspoonful of the paste obtained by rubbing the roots of the plant on a stone with a little lime juice completely cures respiratory troubles when administered orally twice daily for three days.

CHEMICAL COMPOSITION.—The chemical analysis of the roots was first attempted by Phalinkar (1948) who isolated a carbohydrate, dulcitol, from the alcoholic extract of the root bark. Bhatnagar and co-workers (1951) examined the roots and isolated besides dulcitol, an antibiotic pristimerin, $C_{27}H_{34}O_4$, m.p. $219-20^{\circ}C.$, to the extent of 0.1 per cent. The roots consist of an outer yellow covering (phellem) an inner red bark and pitch. The antibiotic was mostly concentrated in the phellem and to a lesser extent in the inner red bark, the pith being completely devoid of any antibacterial activity.

Pristimerin shows considerable activity *in vitro* against a large number of gram positive cocci, particularly against *Streptococcus viridans*, the casual agent of sore throat, tonsilitis, streptococcal arthritis, etc., and *Streptococcus faecalis* which at times is known to cause urinary complications. It is ineffective against gram negative organisms. The activity of the antibiotic *in vivo* was found to be of a low order and when administered parenterally it was found to be toxic.

CLINICAL TRIAL OF PRISTIMERIN.—Nineteen cases treated presented a low grade infection of the nasopharyngeal mucosa which did not yield to sulpha drugs or penicillin. The chief pathological changes were confined to the tonsils from which alpha-haemolytic strains belonging to the viridans group were isolated. Patients of age group 4 to 46 years, the majority being young, were treated by direct application of pristimerin in paroleine or glycerin, and by 20 mg. doses in alcohol by mouth twice a day for 2-3 days. Recession in the size of the tonsil, amelioration of general malaise and disappearance of temperature was observed. No alpha-haemolytic streptococci could be isolated from the throat swabs after the completion of treatment.

This antibiotic deserves further careful laboratory studies as well as clinical trials.

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PSORALEA CORYLIFOLIA Linn. (Leguminosæ)

BABCHI

VERN.—Beng.—*Bavachi*, *Hakuch*, *Latakasturi*; Bomb.—*Bawachi*; Hind.—*Babachi*, *Babchi*, *Bavanchi*, *Bhavanj*, *Bukchi*; Guj.—*Babchi*, *Bavacha*; Mar.—*Babachi*, *Bavachya*; Pers.—*Waghchi*; Punj.—*Babchi*; Sans.—*Aindavi*, *Avalguja*, *Bakuchi*, *Chanderlekha*, *Chanderprabha*, *Kushthahantri*, *Shashilekha*, *Shulotkha*, *Sitavari*, *Soma*, *Vejani*; Urdu.—*Babechi*.

P. corylifolia is a common herbaceous weed which grows throughout the whole length and breadth of the plains of India. The seeds of this plant have been in use in the Hindu medicine for a long time. They are brownish black in colour, about 2 mm. long and are oblong and flattened. They are hard but not brittle, have a soft skin, an agreeable aromatic odour and a pungent bitterish taste. No oil can be expressed from the seeds even under high pressure. A good quality of the seed is produced in Rajputana which can be bought in the market at Rs. 15/- to Rs. 20/- per maund.

The seeds have been described by the ancient Hindu physicians as 'hot and dry' and according to some 'cold and dry, laxative, fragrant, stimulant and aphrodisiac'. They have been specially recommended in leprosy internally and are also applied in the form of paste or ointment externally. The drug has been considered to be so efficacious in this disease that it was given the name of 'kushtanasini' (leprosy destroyer). In inflammatory diseases of the skin leucoderma and psoriasis it is given both as a local application and by the mouth. The seeds are also used as an anthelmintic, diuretic and diaphoretic in febrile conditions. Several species of *Psoralea* grow in America and are used medicinally in that country as a stimulant and as nerve tonic.

CHEMICAL COMPOSITION.—Dymock in his *Pharmacographia Indica* states that the seeds contain a colourless oil, 13.2 per cent. of extractive matter, albumin, sugar, ash 7.4 per cent. and a trace of manganese. Very little work was done on this drug until recently, when Sen, Chatterjee and Datta (1923) made a thorough examination of the seeds. These authors found that the seeds contained—(1) an unsaponifiable oil having the formula $C_{17}H_{24}O$ boiling between $180^{\circ}C.$ and $190^{\circ}C.$ at 11 to 15 mm.; (2) a yellow acid substance $C_{40}H_{45}O_{10}$ from the alcoholic extract; (3) a methyl glycoside having a melting point of $105^{\circ}C.$ to $107^{\circ}C.$ containing four (OH) groups. They found the unsaponified oil to be pharmacologically active and they used it with success in cases of leucoderma and psoriasis. They did not, however, study the essential oil present in the seeds, which was associated with the unsaponifiable oil.

Chopra and Chatterjee (1927) studied the chemistry of the seeds. The chief active principle is an essential oil. A fixed oil, a resin, and traces of a substance of alkaloidal nature are also present. The essential oil was more closely studied by these workers. The crushed seeds were distilled in steam and the distillate collected. The distillate was saturated with common salt, when most of the oil floated at the top and was repeatedly extracted

with ether. The ethereal extracts were collected and dried with anhydrous sodium sulphate. On slowly evaporating the solvent a straw-coloured essential oil having the characteristic odour of the seeds was obtained, the yield being 0.05 per cent. The following constants were determined: Sp. gr. at 25°, 0.9072; refractive index 1.5025; solubility in water at 25° about 0.0197 per cent. It was found to be optically inactive. The essential oil when stored in a sealed tube remained unchanged for a considerable period; the colour, however, gradually turned to a deep brown. When placed in a desiccator over calcium chloride or exposed to air, it crystallised in needles, probably on account of the oxidation of some of its constituents. The crystals had a sharp cooling taste; they melted sharply at 126°C. If the temperature was further raised to 330°C, they slowly turned black, showing the decomposition of the substance at a high temperature. On cooling it was found that a well-defined needle-shaped crystalline sublimate had deposited on the cooler parts. As the quantity of the essential oil at our disposal was very small, it could not be fractioned *in vacuo* to study its constituents. Jois (1933) obtained from the petroleum ether extract of the seeds a reddish brown oil and a crystalline solid psoralen, $C_{11}H_6O_3$, m.p. 162°C., it is possibly a coumarone-coumarin. The oil contained considerable amount of resin. The fatty acids separated from the oil were principally palmitic, oleic and linoleic together with small quantities of stearic, lignoceric, and linolenic acids. Seshadri (1937) obtained by extraction of the entire seed with ether an alkali soluble resin, an essential oil and a non-volatile terpenoid oil. From the crushed kernels with petroleum ether he obtained a mixture of psoralen and isopsoralen and fixed oil from which a sterol, m.p. 126-28°C. was isolated. Siddiqui (1948) from the kernels isolated psoralen m.p. 169°C., isopsoralen, m.p. 142°C. and a fixed oil. From the sticky resinous pericarp, he obtained essential oils, resin acids and a new crystalline substance psoralidin, $C_{16}H_{14}O_4$, m.p. 315°C.

PREPARATION OF THE OLEO-RESINOUS EXTRACT FOR CLINICAL TRIALS.—One pound of the powdered seed was thoroughly mixed with 1 lb. of olive oil and the mixture was kept overnight. Next day, it was transferred into a tincture press and the oil was expressed. About half a pound of oil was collected and filtered through cotton wool. The oil was diluted with fresh olive oil according to requirements.

PHARMACOLOGICAL ACTION OF THE ESSENTIAL OIL.—The oil has an irritant effect on the skin and mucous membrane. Its action on undifferentiated protoplasm such as paramecium is quite marked. In 1 in 50,000 dilutions of the essential oil, the paramecia remain alive and active for 15 minutes; after 25 minutes the movements are somewhat slowed and some die in 40 to 45 minutes. In 1 in 10,000 dilution these organisms are killed in 10 minutes. The essential oil shows a selective activity against the skin streptococci and this in all probability accounts for its extensive use by the Hindu physicians in skin affections. Dilutions of 1 in 10,000 kill streptococci in 10 minutes. Against *B. typhosus* (Calcutta strain) the essential oil has no activity at all and there was growth of these bacilli in all concentrations. The action of the essential oil on the cholera vibrio and *B. dysenteriae* was tried with results similar to those obtained with *B. typhosus*. The following table gives the relative effects of 1.0 per cent. phenol and different dilutions of the babchi essential oil on the skin streptococci:

	Time in Minutes			
	2½	5	7½	10
Phenol, 1.0 per cent.	—	—	—	—
Saturated aqueous solution of essential oil (1 in 5,000) +	—	—	—	—
Dilution 1 in 10,000	+	+	+	—
„ 1 in 25,000	+	+	+	+
„ 1 in 50,000	+	+	+	+

+ means growth; — means no growth.

+ means growth; — means no growth.

On voluntary muscle, the essential oil in high dilutions (1 in 50,000 to 100,000) has a distinct stimulant action. The tone of the isolated uterus of the guinea pig or cat is decidedly increased and the uterus may show a tonic contraction. Perfused, isolated pieces of intestine are similarly affected and the peristaltic movements are increased. Saturated solutions of the oil injected intravenously have no effect on the blood pressure. The isolated mammalian heart shows neither stimulation nor depression. On perfusion with 1 in 5,000 solution of the oil there is a well-marked contraction of the arterioles in a frog. The respiration is not affected.

THERAPEUTIC USES.—*P. corylifolia* is a very ancient remedy for leucoderma; it has been tried extensively not only by the practitioners of the Hindu medicine but also by followers of the Western system. K. L. Dey strongly recommended an oleo-resinous extract and he describes the effects as follows: "After application for some days the white patches appear to become red or vascular; sometimes a slightly painful sensation is felt. Occasionally, small vesicles or pimples appear and if these be allowed to remain undisturbed, they dry up, leaving a dark spot of pigmentary matter, which forms as it were a nucleus. From this point as well as from the margin of the patch, pigmentary matters gradually develop, which ultimately coalesce with each other and thus the whole patch disappears. It is also remarkable that the appearance of fresh patches is arrested by its application." Other observers have not obtained such good results.

Acton (1926) tested a number of preparations made from *P. corylifolia* seeds in various skin affections at the skin out-patient department, Calcutta School of Tropical Medicine, 1 in 10,000 to 1 in 20,000 solutions of the pure essential oil were tried in some cases of acute streptococcal dermatitis, but unfortunately they set up much irritation and made the condition worse. A 20 per cent. solution of the purified resin in alcohol was quite ineffective in leucoderma. A 1.0 per cent. solution of the essential oil in alcohol was also unsatisfactory. The oleo-resinous extract made from the seeds was found to be the most suitable preparation; this contains most of the essential oil present in the seeds. This oil was applied locally to leucodermic patches by gently rubbing once or twice daily. Patients suffering from leucoderma are divided into two groups:

1. *The Primary Group*: These patients do not suffer from any other skin disease. They are sub-divided into (a) those of syphilitic origin and (b) those of non-syphilitic origin. Some of them suffer from *E. histolytica* infection and other affections of the gastro-intestinal tract. Others are free from it.

2. *The Secondary Group*: This includes cases which are associated with other diseases of the skin such as ringworm, seborrhoeic dermatitis, etc.

The oleo-resinous extract has been tried in a very large number of cases of leucoderma of both groups, but its beneficial effects are observed only in the non-syphilitic groups. In the syphilitic cases it had no effect, because here in all probability the melanoblasts are killed, as they are not visible in the histological preparations. The effect of the essential oil is purely local. The Hindu physicians give the powdered babchi seeds by the mouth but this method was not tried in the treatment of leucoderma. The beneficial effects may be due to: (1) absorp-

tion and excretion of the oil through the skin where it produces its specific action, (2) stimulant action on the intestinal mucosa which may cause increased absorption of amino acids concerned in pigment formation, or (3) antiseptic action in the gastro-intestinal tract, but this is not borne out by our experiments. The effect of the essential oil is purely local and, therefore, any existing concurrent affections of the gut such as infection with *E. histolytica* should be treated at the same time. The action of the oil on the skin appears to be specific. Krogh has demonstrated that Rouget's cells lie round the capillaries. The endothelium of the capillaries by itself has no contractile power and any increase or diminution in the size of these vessels is brought about through the agency of the processes of Rouget's cells. In the skin the melanoblasts or pigment-producing cells lie in the vicinity of Rouget's cells. When the capillaries dilate Rouget's cells also increase in size and the melanoblasts relax at the same time. During relaxation of the melanoblasts their processes are extended and they exude the pigment *melanin*. The main action of the essential oil appears to be on the arterioles in the sub-capillary plexuses causing dilatation and increase of plasma in this area so that the skin becomes red and the melanoblasts are stimulated. The action on the capillaries in the papillae is usually very slight in most individuals so that there is no oedema of the prickle cells layer (poro-keratosis) and there is no desquamation of the epithelium.

The essential oil, however, varies enormously in its effects on different persons. With the majority (95 per cent.) it causes only redness of the leucodermic patches but in a small number (5 per cent.) there is extreme sensitiveness to the oil, so much so that blistering may be produced. This indicates that not only is dilatation of the blood vessels produced, but at the same time the permeability of the capillary tufts is markedly increased so that fluid accumulates and blisters form between the prickle cells and the capillary layer of the skin. In yet another class of cases blistering only occurs after the application of the oil if the skin is exposed to the direct rays of the sun. The strength of the oil should, therefore, be varied in such a way as not to allow its action to go beyond the state of redness of the leucodermic patches. The oil being an essential oil is able to permeate through the epidermis to the prickle cells of the lymphatics and so it finds its way to the sub-capillary area and stimulates the cells situated there. The advantage of this oil over the other skin irritants (compounds of mercury, salicylic acid, etc.) is that it does not produce desquamation or any change of keratolytic nature resulting in loss of pigment of the epidermis. So far as is known *P. corylifolia* is the only drug that has a dual action, i.e., action on both Rouget's cells and the melanoblastic cells of the skin. This specific action of the oil can be readily demonstrated on the frog's skin under a microscope. In leucoderma the melanoblastic cells are not functioning properly and their stimulation by the oil leads them to form and exude pigment which gradually diffuses into the decolourised areas.

SUMMARY.—The active principle of the seeds of *P. corylifolia* (babchi) is an essential oil. A fixed oil and a resin occur in large quantities but these are

not pharmacologically active substances. Traces of substances of alkaloidal nature are also present. The essential oil has a powerful effect against the skin streptococci. It has a specific effect on the arterioles of the sub-capillary plexuses which are dilated so that in this area plasma is increased. The skin becomes red, the melanoblasts are stimulated leading to pigment formation. The pigment is exuded and diffuses into the decolourised leucodermic patches. Local applications of the oleo-resinous extracts made from the seeds are beneficial in the treatment of cases of leucoderma of non-syphilitic origin. If affections of the gastro-intestinal tract such as *E. histolytica* infections, etc., are present, these should be treated at the same time.

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RANDIA DUMETORUM Lam. (Rubiaceæ)

VERN.—Arab.—*Jauzulaki, Juzulosul*; Assam.—*Gurol*; Beng.—*Madan, Menphal*; Bomb.—*Ghela, Gehela, Gelaphal*; Eng.—*Common emetic nut*; Gond.—*Katul, Kuay*; Hind.—*Arar, Karhar, Madan, Maindal, Mainphal, Manneal*; Kumaon.—*Karhar, Mainphal, Manyul*; Mal.—*Kara, Kattunaranna*; Mar.—*Galay, Gel, Mindhal, Peralu*; Pers.—*Juzulkueh*; Punj.—*Arar, Mandkolla, Mindla*; Sans.—*Bastishodhana, Dharaphala, Granthiphala, Kantaki, Kantha, Muchukunda, Pichuka, Pindinatta, Tagara*; Urdu.—*Mainphal*.

This is a deciduous thorny shrub or small tree found throughout India. The dried fruit has been known to Ayurvedic and Unani practitioners for a long time as an emetic and ecboic (Dymock, 1891). It is described by the old Hindu writers under the name of Madna as pungent and dry, beneficial in leprosy and phlegmatic swellings and the best and the safest of emetics. Mohammedan physicians of India have adopted it as a substitute for the Jouz-el-kai of Arabs and describe it as an emetic, at the same time acting as an aperient. Mohideen Sheriff (1869) described the dry mucous pulp as a good substitute for ipecacuanha in dysentery. Chevers on the authority of Edgeworth, stated that the fruit is used in Jullundar as an ingredient in medicines given by the mouth for the purpose of procuring abortion (Waddell, 1928). Dymock and others have also mentioned it being used as a fish poison and as a preservative for protecting grain from insects. The plant is also recommended as an antidote to snake-bite and scorpion sting but Caius and Mhaskar found it quite useless. The root is also useless as collyrium.

CHEMICAL COMPOSITION.—Vogtherr (1894) isolated from the plant a minute quantity of an alkaloidal substance which was neither identified nor characterised. A small amount of lead (0.022 per cent.) is invariably present. In addition to the above Randia saponin has been isolated and also a glycoside which forms yellowish plates or white amorphous powder

which melts and decomposes at about 250°C. Tannic acid, $C_{30}H_{52}O_{10}$, appears to be a monobasic acid of the saponin series and exists apparently in loose combination with *Randia* saponin. It crystallises from alcohol in white nodular masses and melts at 208°C. Randic acid resembles quillozic acid in dissolving red blood corpuscles without destroying the colouring matter and in precipitating albumins and peptones. Such properties of *randia* saponin are probably responsible for the poisonous character of the fruit. *Randia* tannic acid exists in small quantities in the pericarp and is a brown, very hygroscopic mass which is freely soluble in ether as well as in water and alcohol. *Randia* red, $C_{33}H_{34}O_2$, probably a decomposition product of *randia* tannic acid, to which the red colour of the pericarp of the fruit is due, is precipitated from the alkaline extract as a brown powder which is insoluble in water, alcohol and ether but easily soluble in alkalis. *Randia* fat is a yellowish green substance of the consistency of butter. It melts at 28-29°C, its specific gravity is 0.9175 at 20°C, acid value 13.8, ester value 146.4, saponification value 160.2, iodine value after two hours 43.24. Hardikar and Mohiuddin (1937) obtained from the brown kernel of the ripe fruit, an essential oil having the characteristic smell of the plant; a neutral saponin as a white, brittle amorphous mass (melting point between 230 and 340°C.); an acid saponin as brownish white material melting between 195 to 200°C. and an acid resin.

PHARMACOLOGICAL ACTION.—The plant has a bitter taste and produces salivation. On contact it produces a generalised irritation of the mucous membranes producing sneezing, vomiting and irritation and bleeding from the urinary tract. The cornea is inflamed and the drug causes haemolysis both in vitro and in vivo. The perfused frog's heart is arrested in a few minutes with concentration of 1/75,000 and practically instantaneously with a 1/50,000 concentration. The drug is rapidly detoxicated by the liver.

No clinical trials on any large scale have so far been carried out. The saponin is probably responsible for its action.

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RAUVOLFIA CANESCENS Linn. (Apocynaceæ)

It is a small shrub inhabiting the moist and hot regions of India. It grows wild in Howrah district near Calcutta in Bengal. No mention of the plant is made either in Watts Dictionary of Economic Products of India or in Hooker's Flora of British India. Its roots are sometime used to adulterate those of *R. serpentina*.

CHEMICAL COMPOSITION.—Greshoff (1890) first reported the presence of 0.4 per cent. of a body of alkaloidal nature in the bark of the plant but he did not purify the base or determine its molecular formula and properties. Asima Mookerjee (1941) reinvestigated the plant and isolated from the leaves an alkaloid Rauwolscine, $C_{21}H_{26}O_8N_2$, with m.p. 231-32°C. It is fairly soluble in ether, ethyl acetate, chloroform and hot alcohol, less soluble in benzene and very sparingly soluble in petroleum ether and water. The colour reactions of the alkaloid show it to be quite different from other *Rauvolfia* alkaloids but similar to yohimbine. Rauwolscine is distributed throughout the plant, the root bark containing 0.1 per cent., stem-bark 0.2 per cent. and leaves 0.5 per cent.

PHARMACOLOGICAL ACTION.—Rauwolscine has been found to be a depressant of the cardio-vascular system in experimental animals. The important feature is

that the alkaloid exerts its hypotensive action only when the blood pressure is high. It lowers the blood pressure by depressing the cardiac muscle and reducing the minute output of the heart. This reduction in blood pressure is maintained in most cases indicating an action also on the blood vessels. The alkaloid ranks among the few sympatholytic agents and a suitable dose can completely abolish the pressor effects of adrenaline. It appears from some experimental work done that the alkaloid is fairly toxic, but no exact figure can be quoted at present unless further data are collected. As it is chemically related to Yohimbine, it is yet to be seen whether rauwolscine shares other properties of the latter. This alkaloid deserves further notice of the pharmacologists and clinicians. Although its pharmacological action has not been fully investigated, its action so far as blood pressure is concerned resembles that of *R. serpentina*. Further work on the plant is indicated.

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RAUVOLFIA SERPENTINA Benth. (Apocynaceæ)

VERN.—Beng.—*Chandra, Chhotachand*; Bomb.—*Amelpodi, Chandra, Chhotachand, Karavi, Tchovanna*; Hind.—*Chhotachand, Harkai chanda, Nai, Nakulikanda*; Mal.—*Chuvannavilpuri, Tulunni, Vantuvala*; Mar.—*Harkaya, Mungusavel, Sapasanda*; Sans.—*Ahibhuka, Ahilata, Bhadra, Bhujangakshi, Chandrasura, Chandrika, Ishwari, Mahasugandha, Nagagandha, Patalaganda, Phanihantri, Vasara*; Tam.—*Sovannamilbori*; Tel.—*Dumparasna, Patalagandhi, Patalagaruda*.

It is a large climbing or twining shrub found in the tropical Himalayas and in the plains near the foot of the hills from Moradabad to Sikkim. It occurs in Assam, Pegu, Tennasserim at altitudes up to 4,000 ft. and in the Deccan Peninsula along the Ghats to Travancore and Ceylon. It grows wild in many districts of north Bihar and in Patna and Bhagalpur. It is also obtainable in Java and Malaya Peninsula. The root of *R. serpentina* has been much valued in India and the Malayan Peninsula from very ancient times as an antidote for the bites of poisonous reptiles and the stings of insects. It has also been used as a febrifuge in many places. It is said to stimulate the uterine contractions and promote the expulsion of the foetus. Recently the drug has attained prominence as a remedy for insomnia, hypochondria, etc. There is no mention of this property in any book on Indian medicinal plants. The hypnotic action of the drug appears to have been known to the poorer classes in Bihar and the practice of putting children to sleep by this drug is stated to be still present in certain parts of that province. In the Uttar Pradesh and Bihar, the drug is sold as 'pagal-ka-dawa' (insanity specific) and its use is common amongst the practitioners of the indigenous medicine. The popularity of the root may be estimated from the fact that many maunds are consumed every year in Bihar alone.

CHEMICAL COMPOSITION.—On account of the popularity of the drug in the indigenous medicine, chemical examination of the roots has been carried out by a number of workers. Sen and Bose (1931) have found two alkaloids in the root with different melting points. The quantity of the total alkaloids has been estimated to be fairly high amounting to about 1 per cent. of the dried roots. The root also contains a lot of resin and starch and when incinerated leaves about 8 per cent. of ash consisting mainly of potassium carbonate, phosphate, silicate and traces of iron and manganese.

S. Siddiqui and R. H. Siddiqui (1931) have found five new alkaloids to which they have given special names as follows:

Group A—Ajmaline group, consists of three white crystalline weak bases.

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|---|--------------------------------|
| 1.— <i>Ajmaline</i> ($C_{20}H_{26}O_2N_2$), | M.P. 158-60° (0.1 per cent.). |
| 2.— <i>Ajmalinine</i> ($C_{20}H_{23}O_4N$), | M.P. 180-81° (0.05 per cent.). |
| 3.— <i>Ajmalicine</i> — | M.P. 250-52° (0.02 per cent.). |

Group B—Serpentine group—two bright yellow crystalline stronger bases.

- | | |
|---|--------------------------------|
| 1.— <i>Serpentine</i> ($C_{21}H_{23}O_4N$), | M.P. 153-54° (0.08 per cent.). |
| 2.— <i>Serpentinine</i> , M.P. 263-265° | (decomposes) (0.08 per cent.). |

Other constituents identified are:—(a) a phytosterol, (b) oleic acid, and (c) unsaturated alcohols of formula $C_{25}H_{44}O_2$.

Siddiqui (1939) working with the root of the drug collected from the hot swampy district of Bihar found that they contain the white crystalline bases ajmaline, ajmalinine, ajmalicine and the bright yellow crystalline bases serpentine and serpentinine. Roots from climatically milder Dehradun variety contain very little of the yellow group of bases which are oxidation products of the white ajmaline series. The Dehradun drug contained no ajmaline and very little of ajmalinine and ajmalicine. The yield of isoajmaline (m.p. 264-6°C.), neoajmaline (m.p. 205-7°C.) was 0.1 and 1 per cent respectively, from the root bark, the yield was 0.01 and from the whole root 0.1 per cent. Another new alkaloid of this group, m.p. 220°C. and a white crystalline amphoteric alkaloid, m.p. 234°C., were also isolated in proportion of 0.02 and 0.1 per cent., from the root and root bark. Van Italic (1932) isolated three alkaloids from the root. The main alkaloid rauwolfine, $C_{21}H_{26}O_2N_2$, m.p. 160°C. is possibly identical with ajmaline, $C_{20}H_{26}O_2N_2$. The second alkaloid isorauwolfine corresponds to serpentinine and third one to ajmalinine. Chatterjee and Bose (1951) while working with the root isolated a new alkaloid rauwolfinine, m.p. 235-36°C. (decomp.) formula, $C_{19}H_{26}O_2N_2$, in 0.02 per cent. yield.

Schlittler and co-workers (1952) isolated from the oleoresin fraction of the root extract a new alkaloid reserpin, m.p. 262-63°C. in crystalline form. This is supposed to be one of the hypnotic principles of the drug. Dutt and co-workers (1947) estimated the presence of total alkaloids in the root by a new method and found that it contains 1.21 to 1.36 per cent. of alkaloids. On the basis of these results they recommended a standardized alcoholic extract containing about 0.5 per cent. of alkaloid for clinical trials. This extract or tincture manufactured by different commercial firms is used by the medical profession in India for the treatment of hyperpiesis and maniacal types of insanity.

PHARMACOLOGICAL ACTION.—The pharmacological actions of the active principles of the drug have not yet been worked out satisfactorily. According to Siddiqui and Siddiqui (1931) the white and yellow bases isolated from two distinct groups form the stand-point of physiological action. The former (Ajmaline group) acts as a general depressant to the heart, respiration and nerves and the latter (Serpentine group) paralyses the respiration and depresses the nerves but stimulates the heart. These observations were drawn from experiments carried out on frogs and, therefore, cannot be interpreted in toto in higher animals.

The lethal dose of the serpentine group of alkaloids was found to be the same as that of the ajmaline group, viz. 0.5 mg. per kilo of frog. The lethal dose for rats was found to be four times higher. Sen and Bose (1931) studied the pharmacological action of the drug on higher animals such as cats. They found that watery extract of the whole drug when injected intravenously in animals produces no appreciable effect. The resins have also been separately tried but without effect on the system excepting a slight stimulation of the uterine musculature. The alkaloids isolated by them, however, showed definite results.

According to Chopra *et al* (1933-43) extracts of *R. serpentina*, the total alkaloids of the drug and the alkaloid serpentine, lower the carotid blood pressure, depress the cardiac musculature, produce splenic contraction, stimulate respiration and increase peristalsis of the guinea-pig intestine. Serpentine and the total alkaloids from the plant have the opposite effect on these organs. In hypertension induced in cats by adrenaline or ephedrine, the blood pressure is lowered by the total alkaloids and by serpentine and to a less extent by ajmaline and serpentinine. In 1943, Chopra *et al* stated that in addition to the medullary stimulant effects of ajmaline and serpentinine, there is present in *R. serpentina* a hypnotic principle, because: (a) an alcoholic extract of the drug, (b) the total alkaloids of the drug, and (c) the residue left after removal of the three alkaloids named above from the total alkaloids, all have sedative and hypnotic effects. This component antagonises the medullary stimulation produced by picrotoxin. Gupta, Kahali and Dutt (1944) found that a resinous, non-alkaloidal fraction from the Dehradun variant of the plant, exerted the characteristic sedative action for which Rauvolfia preparations are used clinically in India, and suggested that for this purpose the resin freed from alkaloids should be used. The iso- and neo-ajmalines found in this Dehradun variant have been examined by Bhatia and Kapur (1944) who found that both have a slight stimulant action on the nervous system followed by depression. These produce depressant effects on plain muscle of the heart, blood vessels and intestine and lower blood pressure in intact, decerebrate and spinal animals under normal conditions or after experimental hypertension. Neo-ajmaline has a powerful stimulant action and iso-ajmaline a slight depressant effect on rabbit and guinea-pig uterus. Gupta and Kahali have examined total alkaloids from *R. serpentina* collected in three districts and note that the differences in action observed are due to the variation in the relative amounts of the individual alkaloids present.

Raymond-Hamet has given much attention to the action of the Rauvolfia alkaloids. Using Siddiqui's ajmalinine, he found that it provokes hypotension accompanied by renal dilatation and exerts a true sympathicolytic action. Ajmaline and serpentine also induce hypotension and decrease in intestinal action; serpentinine diminishes the renal constrictive action of adrenaline, but does not alter its hypertensive effects. Reserpine a new alkaloid isolated recently has been found to be a strong and long duration central sedative. In small doses of 0.01 mg./kg. intravenously in rabbits and 1 mg./kg. orally in dogs the animals are put to sleep for a long period. By giving higher doses of the alkaloid the effect is reversed.

This plant has attracted considerable attention of workers in Europe and America and much work is being done on the chemistry and pharmacological action of different alkaloids contained in it.

The drug is not an irritant when taken by the mouth or when introduced into the system by hypodermic or intramuscular injections. Roy (1931) finds that the reflexes and the sensation of pain are not affected by ordinary doses of the drug; if, however, the dose is large it produces deep sleep, the reflexes and sensation of pain are diminished and death may result from asphyxia due to paralysis of the respiratory centre. The heart goes on beating for some time after the failure of respiration.

THERAPEUTIC USES.—The popularity which the drug has attained as a specific for insanity amongst lay people shows that it probably possesses well-marked sedative properties. The drug has been tried by Sen and Bose in cases of insanity with violent maniacal symptoms and in cases of high blood pressure. Doses of 20 to 30 gr. of the powdered root twice daily produce not only sedative effects but also a reduction of the blood pressure. Within a week the patient's senses are said to be restored, though in certain cases the period of treatment has to be prolonged. In high blood pressure without marked atheromatous changes in the vessels, these authors find the drug very satisfactory. Claims regarding its utility in fevers and during the puerperium have not been thoroughly tested, but it would certainly be worth while to try the drug on a more extensive scale. From the data so far obtained, it promises to be a valuable addition to the list of existing sedatives in insanity and irritative conditions of the central nervous system. A large amount of pharmacological and clinical study will have to be done before the utility of the drug is fully established.

Gupta and co-workers (1943) treated fifteen patients suffering from various types of mental disorders with the standardized extract of *R. serpentina* Benth. Of these, five suffered from disorder of the affective reaction type, seven from schizophrenia, two from organic psychoses and the remaining one from chronic epilepsy. All of these patients suffered from insomnia and showed considerable motor and mental agitation. The epileptic patient had less frequent major and minor fits. The extract was given daily at noon and at bed time usually in 30 minim doses. Sleep ensued 2 to 3 hours after the evening dose and lasted for more than 6 hours. The patients became quiet and behaved more normally and those suffering from affective disorders showed considerable improvement. In the epileptic, the major fits were stopped and the minor fits were controlled, with great clinical improvement. The alimentary functions of the patients were stimulated and appetite improved.

Chakravarty and Chaudhuri (1951) treated 15 cases of essential hypertension with *R. serpentina* alkaloid. A definite fall of systolic pressure (15 mm. or more) and diastolic pressure (10 mm. or more) was seen on the same day after treatment in 80 per cent. and 100 per cent. respectively and on the last day of treatment in 70 per cent. and 53.3 per cent. respectively. The maximum fall noticed was

53 mm. systolic and 30 mm. diastolic. Two patients showed transient untoward symptoms such as nausea, fainting and dyspnoea during treatment.

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SARACA INDICA Linn. (Leguminosæ)

THE ASOKA TREE

VERN.—Beng.—*Asoka*; Bomb.—*Ashok*, *Jasundi*; Eng.—*Asoka tree*; Guj.—*Ashopalava*; Hind.—*Ashok*, *Asok*; Mal.—*Asoka*, *Vanjulam*; Mar.—*Ashoka*; N. W. P.—*Asok*; Punj.—*Asok*; Sans.—*Anganapriya*, *Apashoka*, *Ashoka*, *Chitra*, *Doshahari*, *Kankelli*, *Shokanasha*, *Vanjula*, *Vanjuldruma*, *Vichitra*, *Vitashoka*; Tam.—*Asogam*, *Asogu*, *Anagam*, *Sasubam*; Tel.—*Asokamu*, *Vanjulamu*.

S. indica is one of the sacred trees of the Hindus and is found plentifully along the roadside in Eastern Bengal which is probably its original home. It grows abundantly in Southern India, Aracan and Tenasserim. In the Uttar Pradesh, near Kumaon, the tree occurs up to an altitude of 2,000 ft. It is cultivated in many parts on account of its handsome flowers. The bark of the tree is largely prescribed in Ayurvedic medicine as an astringent and uterine sedative. It is said to have a stimulating effect on the endometrium and on the ovarian tissue. It is largely used in uterine affections, especially menorrhagia due to uterine fibroids and other causes. A decoction in milk is one of the most favourite prescriptions of the Kavirajes even to this day. It has also been used in haemorrhoids and dysentery.

CHEMICAL COMPOSITION.—The chemistry of the bark has not been worked out satisfactorily. Abbott (1887) stated that it contained haematoxylin. Hooper (Pharm. Indica) recorded the presence of a fair amount of tannin. The dry powdered bark was extracted with different solvents in the Department of Chemistry of the School of Tropical Medicine with the following results:—petroleum ether extract 0.307 per cent., ether extract 0.235 per cent., and absolute alcoholic extract 14.2 per cent. The alcoholic extract, which was mostly soluble in hot water showed the presence of a fair amount of tannin and probably an organic substance containing iron. No active principles of the nature of alkaloid, essential oil, etc., were found. Gupta (1939) re-investigated the bark and found that it contains tannins and catechol. Ghosh (1953) investigated the powdered bark of *S. indica* and found in the ash presence of silica, sodium,

potassium, phosphate, magnesium, iron, calcium, strontium and aluminium. He isolated from the bark a crystalline glycosidal substance with galactose as the constituent sugar. The compound is very labile and deteriorates rapidly. It does not melt till 250°C. and turns brown at 160°C. It stimulates the uterine contraction. Besides this another active principle has also been detected in the bark which contrary to the previous substance depresses the uterine contractions.

PHARMACOLOGICAL ACTION AND THERAPEUTIC USES.—Various fractions isolated from the bark were tried on the isolated uterus and uterus *in situ* but no marked action was produced. The drug does not appear to have marked therapeutic effects, though many clinicians appear to vouch for its efficacy in menorrhagia and other uterine disorders.

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SAUSSUREA LAPPA Clarke (Compositæ)

THE COSTUS

VERN.—Arab.—*Kust, Kustabeheri, Kustullhalu*; Beng.—*Kur, Pachak*; Bomb.—*Ouplate*; Eng.—*Costus*; Guj.—*Kut, Upaletta*; Hind.—*Kot, Kust, Kut, Pachak*; Kash.—*Postkkhai*; Mal.—*Sepuddy*; Pers.—*Koshnaha, Kust, Kuttalkh*; Punj.—*Kot, Kust, Kuth*; Sans.—*Agada, Amaya, Apya, Bhasura, Dushta, Gada, Jarana, Kinjalka, Kushtha, Kuthika, Kutsita, Padmaka, Pakalam, Paribhadraka, Vyadhi, Vyapya*; Tam.—*Goshtam, Kostum, Putchuk*; Urdu.—*Kut*.

S. lappa is a tall, stout herb having an annual stem and perennial roots. Many species of *Saussurea* grow in the Himalayas at an altitude ranging from 2,000 ft. to 13,000 ft. above the sea level. The only species which has been used for its medicinal properties is *S. lappa* which grows in the north-western portion of the Himalayas, especially on the moist slopes of the mountains round the valley of Kashmir. The plant is well-known both in the Ayurvedic and Tibbi medicine. For a long time a good deal of confusion existed as to which one of the large number of species of *Costus* was used for its medicinal properties by the ancients, but Guibourt first suggested the correct botanical source and Falconer, who visited Kashmir, proved beyond doubt that the root of *Aucklandia costus*—now known as *Saussurea lappa*—was the species. The plant grows as a very stout herb with large heart-shaped leaves, and thick perennial roots which are dug up in the autumn and are exported to Calcutta and Bombay in large quantities. From there the root is shipped to China in large quantities and to the Red Sea ports, and is used as a spice, as an incense and medicinally. The uses of this root have been summarised by Baden Powell in his 'Punjab Products' in the following terms:

"1. Dried and powdered as the principal ingredient in an astringent stimulant ointment, applied to severe ulcerations.

2. Dried and powdered as a hair wash.

3. As a stimulant in cholera; an infusion made of cardamoms 1 dr., fresh kut 3 dr., water 4 oz. One ounce every half hour. It is doubtless a powerful aromatic stimulant, and would be serviceable in any spasmodic disease.

4. It is universally employed by shawl merchants as a protector of Kashmir fabrics from the attacks of moth and other vermins.

5. The dried root is an agreeable fumigatory and yields excellent pastilles which burn fairly well.

6. It is exported in enormous quantities to China, where it is used as an incense. In every Hong it is found; no mandarin will give audience until the 'patchak' incense smokes before him; in every Joss-house it smoulders before the Tri-budh deity; in every floating junk in the Chinese rivers, the only home of countless hordes—Budh's image is found, and the smoke of the 'patchak' religiously wends its way heavenwards.... It is said to have the power of turning grey hair black. Carminative, stimulant, antiseptic, prophylactic, astringent, sedative and insecticidal properties are ascribed to this remedy. The Chinese apply it with musk to aching teeth."

The root is smoked in parts of India, and in China as a substitute for opium.

The Kashmir State authorities have found such a large demand for this root that they have started nurseries and cultivate the plant in suitable places for purposes of export. The value of the root may be judged from the fact that its market price in Calcutta at the present time is over Rs. 300/- per maund, i.e. about four rupees or six shillings per pound. For this reason the root offered for sale is frequently adulterated with the root of *Salvia lanata* or *Ligularia* and one of the aconites.

The root only is used in medicine. It is dug up during the months of September and October and is collected in small pieces 2 to 6 in. long. It has a pungent taste, a peculiar fragrant aromatic odour resembling that of the orris root. In the Hindu medicine the root has been used from the earliest ages. It has been described in the 'Nighantu' as a stimulant, useful in cough, fever, dyspepsia, skin diseases and as an aphrodisiac. It is said to be particularly useful in the disease arising from deranged air and phlegm and asthma. The Mohammedan physicians describe it as a diuretic and anthelmintic and use it in the treatment of quartan malaria, leprosy, persistent hiccup and rheumatism. The dried powder is the principal ingredient in a stimulating ointment used for application to ulcers. It also forms part of a stimulating mixture used against cholera asiatica.

CHEMICAL COMPOSITION.—This drug was analysed many years ago (1892) by Schimmel & Co., was found to contain about 1.0 per cent. of an essential oil with a strong fragrant odour. The root forms a very valuable raw material for producing a perfume which closely resembles the violet perfume, and is at present very highly priced. Later, Semmler and Feldstein thoroughly studied the oil and found that it had the following approximate composition: Camphene 0.04 per cent.; phellandrene 0.4 per cent.; terpene alcohol 0.2 per cent.; α -costene 6.0 per cent.; β -costene 6.0 per cent.; aploaxene 20.0 per cent.; costol 7.0 per cent.; di-hydrocostus lactone 15.0 per cent.; costus lactone 10.0 per cent.; costic acid 14.0 per cent.

Little or no attention was paid to the other constituents of the root although Hooper referred to the presence of small quantities of a body of alkaloidal nature. Later, Ghosh and his collaborators (1929) re-investigated the root and succeeded in isolating an alkaloid. The following constituents were separated by them from the root:—(1) An essential oil

1.5 per cent.; (2) an alkaloid for which the name *saussurine* has been suggested 0.05 per cent.; (3) resin about 6.0 per cent.; (4) traces of a bitter substance; (5) small quantities of tannins; (6) inulin about 18.0 per cent.; (7) fixed oil; (8) potassium nitrate, sugars, etc. The leaves of *S. lappa* have also been analysed. They do not contain the essential oil but 0.025 per cent. of the same alkaloid as is contained in the root. The roots were re-investigated by Siddiqui and co-workers (1950). They found that the alcoholic extracts of the roots gave only a faint test for alkaloids. When the roots were extracted with alcoholic ammonia or when the ethereal extract was treated with ammonia a basic fraction characterised through its platinate $C_{40}H_{56}N_2O_2H_2PtCl_4$, m.p. $200^{\circ}C$. (decomp.) was obtained. From the ethereal extract of the roots they isolated a liquid fraction named Kushtin, $C_{20}H_{26}O_2$, b.p. at 3 mm. $176-78^{\circ}C$. They concluded that the plant did not contain any alkaloid and by comparing the formula of Kushtin and chloroplatinate of saussurine they suggested that the base might have resulted through the interaction of ammonia with two mols of Kushtin.

PHARMACOLOGICAL ACTION: Essential Oil.—In such dilutions as 1 in 10,000 the essential oil kills *Paramaecium caudatum* in 10 minutes. It has strong antiseptic and disinfectant properties especially against the streptococcus and staphylococcus. Internally, the oil has a pungent, bitter taste and gives rise to a feeling of warmth in the stomach when taken in small quantities. When the extract made from the root is given by the mouth in such large doses as 10 to 20 c.c., it gives rise to a certain amount of irritation and a feeling of discomfort in the abdomen which may last for several hours, the patient at the same time feeling somewhat drowsy. The essential oil has marked carminative properties. On the isolated intestines of the rabbit even in such high dilutions as 1 in 1,20,000 it has the effect of inhibiting the peristaltic movements and producing relaxation of the gut. Vaso-dilatation is produced in the splanchnic area after intravenous injection of the essential oil. On the circulation the essential oil produces a definite stimulant action. A saturated solution of the oil given intravenously in experimental animals, produced a small but persistent rise of blood pressure; the isolated heart of the rabbit showed a distinct acceleration of both the amplitude and the rhythm. On the lungs, intravenous injections of the essential oil had a broncho-dilator action. It is absorbed from the gastro-intestinal tract and is partly excreted by the lungs producing an expectorant action and partly by the kidney producing diuresis. On the central nervous system the effect of the essential oil resembles that of other volatile oils. Large doses of the extract produce giddiness, headache and drowsiness which cannot be attributed to any of the other active principles. Inhalation of smoke of the powdered root produces a marked depression of the central nervous system and for that reason it was smoked as a substitute for opium.

The Alkaloid Saussurine.—Chopra and De (1929) investigated the effect of saussurine tartrate on the involuntary muscle tissue generally and on the lungs and bronchi particularly. It was shown that in animals the alkaloid produced a definite relaxation of the bronchioles in the same way as adrenaline does. The action was not so powerful as that of adrenaline, takes longer to develop but persists for a much longer time. The alkaloid appears to act chiefly through the vagus centre in the medulla, though direct action on the involuntary muscle fibres of the bronchioles has also some part to play. Saussurine also has a general depressing action on the other involuntary muscle tissues in the body. It decreases the tone of the intestine and stops the peristaltic movements of the gut, if it is given intravenously in animals. The action is partly on the vagus but chiefly on the muscle fibres themselves. Intravenous injections of the alkaloid produce a slight rise of blood pressure in animals due to stimulation of the myocardium. The effect is much more marked on the ventricles than on the auricles. The administration of saussurine revives a failing heart, the beats becoming regular and forceful.

THERAPEUTIC USES.—Following up the anti-spasmodic, broncho-dilator and expectorant actions of the drug, it was extensively tried in the treatment of bronchial asthma. The preparation used for administration was an alcoholic

extract prepared from the root, which contains the essential oil as well as the alkaloid; this was given in $\frac{1}{2}$ to 2 dr. doses. This is prepared in the following manner:

The powdered root (40 mesh) is percolated 6 to 8 times with 90 per cent. alcohol in the cold till nearly exhausted. The major portion of the alcohol is distilled off and the residual extract is concentrated so that 1 c.c. of the extract corresponds to 1 gm. of the air-dried drug.

It has already been shown that saussurine has a depressant effect on the vagal tone. At the same time the essential oil during its excretion into the bronchial mucosa not only relaxes the involuntary muscle fibres of the bronchioles but also liquefies the tenacious sputum and produces a well-marked expectorant action. In this way not only is the spasm relaxed but the congestion of the bronchial mucosa is also relieved. The respiratory passages are thus cleared and the attack is subdued. The senior author's experience, so far as asthmatics in this country are concerned, is that although they suffer from hyper-excitability of both the parasympathetic and sympathetic systems, they show a greater degree of irritation of the vagus than that of the sympathetic. The action of the vagus is increased owing to certain causes not only producing spasm of the bronchial musculature but also vaso-dilatation of the bronchial mucosa. These effects can be relieved by atropine and to a much lesser degree by inhalation of fumes of stramonium, tobacco leaves, etc., which diminish the vagus action, or adrenaline, ephedrine, etc., which stimulate the antagonistic action of the sympathetic. In the vagal predominance adrenaline has only a slight and evanescent effect in overcoming attacks. Not uncommonly the injection of a few minims of this drug may produce a high rise of blood pressure and irregular action of the heart. Neither adrenaline nor ephedrine are suitable in these patients and we have to look for something which will depress the vagal mechanism. The disadvantage of atropine and allied substances is that although they depress the terminations of the vagi they do not relieve the turgescence of the bronchial mucosa. In fact, on account of their tendency to decrease the secretion, they make the sputum more viscid and difficult to expectorate. This is the reason why they are often combined with such drugs as potassium iodide which render the sputum more fluid. This would also explain the beneficial effects produced by *S. lappa* in the vagotonic type of asthma. The drug fails in those patients in whom the causal factors are very potent. Such patients have a high degree of eosinophilia, which is an indication that strong toxic bases are being absorbed into the circulation from some focus, where such factors as a lesion in the nose, enlarged lymphatic glands in the chest, pathological change in the gastro-intestinal tract etc., are present. Even in these patients the drug gives some relief though it may be temporary.

Besides the direct depressant action of the alkaloid on the vagal centre there is another important factor concerned in the anti-spasmodic effect of the drug and that is the reflex inhibition produced by the essential oil, which is an irritant and has a strong penetrating and persistent odour and taste when it enters the stomach. The depressant action of the drug on the algesic areas of the brain also further helps in relieving the spasm. All these factors undoubtedly account

for the rapid effect of the drug in cutting short the paroxysms and stopping further attacks when the extract is being given. The strong smell and the taste of the drug though advantageous in one way have disadvantages also. There are some patients, fortunately a small minority who cannot take the drug on this account and if it is forced on them they vomit it.

The extract is either given by itself in a little water or in the form of a mixture, *e.g.* pot. iodide or pot. bromide gr. v to x, tr. belladonna m. iii to v, tr. lobelia aetheris m. x., ext. Saussurea lappa liq. $\frac{1}{2}$ to 1 dr., spt. chloroformi m. x., aqua ad 1 oz.

The patient is generally advised to take the mixture 3 to 4 times a day and keep a dose by his side when he goes to bed at night. This should be taken immediately when the premonitions of an attack are felt, the paroxysms is usually aborted and the patient goes to sleep again. The disturbance of sleep produced is comparatively much less than if an injection of adrenaline has to be taken or an asthma cigarette has to be smoked. The depressant action of the drug on the central nervous system further helps the patient to fall quickly to sleep. It is better to give the extract by itself, when the drug is being administered to cut short a paroxysm. The author prefers to prescribe it in a mixture, specially when the administration has to be continued for some time to prevent further recurrence of the attacks while the causal factors are being investigated. The drug has no cumulative effect and, therefore, it can be continued for long periods without producing ill effects. No marked tolerance to the drug is observed so that there is no necessity for the dose to be increased. It is preferable to give it for ten days or a fortnight and then to stop it to see if the attacks recur. In many patients in whom the paroxysms are merely due to irritation through some temporary and not a deep-seated cause, the extract combined with general treatment frees the patient for months or years from attacks and the paroxysms do not recur till these factors operate again. It should be understood, however, that the treatment of this symptom-complex is not so easy as would appear. The cause giving rise to the attacks should be discovered and remedied, but this often is not an easy matter and may take considerable time. Unless this is done, a permanent cure cannot be expected.

In the indigenous medicine in India the root of *S. lappa* is used as an aphrodisiac and as a tonic. It has already been pointed out that the essential oil is excreted in the urine and during its passage through the urethra it may produce a certain amount of irritation giving rise to aphrodisiac effects. In the old Sanskrit books the drug has been suggested as a remedy for malaria. It has been tried in a number of cases of different types of this disease with no benefit whatever. The Mohammedan physicians recommend it against rheumatism, as an anthelmintic and against persistent hiccough. While we have undoubtedly obtained beneficial results in the last-named condition, we are unable to attribute any anthelmintic properties to the drug. We have tried the powdered root as well as the alcoholic extract against hookworm, ascaris, trichuris and taenia infections with entirely negative results. Experiments *in vitro* with a number of these entozoa also

showed that the drug was entirely without effect even in very high concentrations. The root, because of the essential oil it contains, is undoubtedly an insecticide and for that reason is used as a protective of shawls and other woollen fabric. The drug has also been extolled for its beneficial effect against leprosy, but Dr. Muir in charge of the Leprosy Research tested both the powdered root as well as the essential oil in a number of patients without any benefit.

SUMMARY.—*S. lappa* or kut root grows on the moist slopes of the northern Himalayas at a height of 8,000 to 13,000 ft. above the sea level. The chief active constituents of the root are:—(i) An essential oil 1.5 per cent., (ii) an alkaloid which has been named saussurine 0.05 per cent., (iii) resin 6.0 per cent. Besides these, there occur a large amount of inulin, traces of a bitter substance, small quantities of tannins, potassium nitrate, sugars, etc. The leaves contain no essential oil but 0.025 per cent. of the alkaloid saussurine. The essential oil has a strong aromatic penetrating and fragrant odour. It has antiseptic and disinfectant properties; it relaxes the involuntary muscle tissue and it is a cardiac stimulant, a carminative, an expectorant and a diuretic. The alkaloid saussurine has a depressant action on the vagus centre in the medulla as well as on the involuntary muscle fibres of the bronchioles and gastro-intestinal tract. It produces a slight but persistent rise of blood pressure and increases the force of contraction and amplitude of the ventricles. The drug has a remarkable effect in controlling attacks of bronchial asthma, especially those of the vagotonic type. The paroxysms are cut short by the combined action of the essential oil and the alkaloid present in the root. The essential oil during its excretion in the lungs not only relaxes the bronchial muscle but has a marked expectorant action which relieves turgescence of the mucosa. It may be pointed out, however, that although the drug relieves asthmatic attacks, it does not produce a permanent cure unless the causal factors are investigated and removed. The drug is also useful in persistent hiccup. The drug has no anthelmintic action, nor has it any action against malaria, leprosy and rheumatism as has been claimed by writers of the indigenous systems in this country.

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SEMECARPUS ANACARDIUM Linn. (*Anacardiaceæ*)

THE MARKING-NUT TREE

VERN.—Arab.—*Beladin*, *Dahnulefaham*, *Habbulfahm*, *Habelkalb*, *Habul-kalab*; Beng.—*Bhela*, *Bhelatuki*, *Velama*; Bomb.—*Bhiba*, *Bhilama*, *Biba*, *Bilambi*; Eng.—*Common marking nut tree*, *Oriental cashew nut*; Guj.—*Bhilamu*; Hind.—*Belatak*, *Bhela*, *Bheyla*, *Bhilawa*;

Mal.—*Chera, Cherkkuru, Cerkkotta, Temprakku*; Mar.—*Bibha, Bibu, Bibwa*; Pers.—*Biladur, Yaladara*; Punj.—*Bhela, Bhiladar, Bhilawa*; Sans.—*Agnika, Agnimukhi, Anala, Antasatva, Arshohita, Arushkara, Avhala, Bhallataka, Bhutanashana, Bijapadapa, Nirdahana, Prithakabija, Sphotahetu, Tapana, Vanhi, Vatari, Vranakrita*; Urdu.—*Bhilanvana*.

It is a deciduous tree of the sub-Himalayan tract from the Sutlej eastward, ascending to an altitude of 3,500 ft. and is found throughout the hotter parts of India as far east as Assam. The tree yields an acrid viscid juice from which a varnish is made. The pericarp of the fruit contains a bitter and powerful astringent principle, which is universally used in India as a substitute for marking ink. The juice of the pericarp of the nut is used in indigenous medicine in small doses both externally and internally. Externally, it is a powerful counter-irritant and a vesicant and has been employed as a local application in rheumatism, sprains and leprotic nodules. Its powerful irritant properties have frequently been made use of by malingerers in producing ophthalmia and skin lesions and also in procuring abortions. Internally, the juice mixed with some bland oil is used in syphilis, scrofulous affections, dyspepsia, piles and nervous debility.

CHEMICAL COMPOSITION.—Very little systematic work was done with regard to the chemical composition of this drug till recently. It was suggested by earlier investigators that the black corrosive juice of the pericarp contained a tarry oil consisting of 90 per cent. of an oxyacid named anacardic acid and 10 per cent. of a higher, non-volatile alcohol called cardol. Naidu (1925) isolated catechol and a mono-hydroxyphenol which he called 'anacardol', besides two acids and a fixed oil from the kernel of the nut. Recently, Pillay and Siddiqui (1931) have studied the composition of the drug. They were unable to find either anacardic acid and cardol or catechol and anacardol as reported by previous investigators. They have succeeded in isolating the following constituents from the juice of the pericarp:

- (1) A monohydroxyphenol, which forms 0.1 per cent. of the extract. This has been named 'semccarpol' (B. P. 185-90°); congealing below 25° to a fatty mass.
- (2) An o-dihydroxy compound forming 46 per cent. of the extract (15 per cent. of the nut). This has been called 'bhilawanol' (this distills at 225-26° and congeals below 5°).
- (3) A tarry, non-volatile corrosive residue forming about 18 per cent. of the nut.

It has been further shown that the pericarp contains 20 per cent. of an oil which can be distilled out of nuts by slowly heating them to 350°C in large retorts. It is a dark viscous, highly vesicant liquid which contain bhilawanol and other compounds. By boiling with formaldehyde and hydrochloric acid or heating with metallic catalyst or heating to 200°C. with 0.5 to 5 per cent. sulphur it is converted into a black resin. Treatment with dilute nitric acid at 0°C., converts it into a light brown varnish. The black resin when thinned with solvents and applied to metal surface and baked at 140-200°C form a very hard tough elastic film which is proof against acid alkali and most organic solvents. It withstands temperature of 300-350°C. and makes a durable glassy black finish which does not chip off even when the metal is bent. The marking nut oil has been used in the preparation of various baking enamels and plasticisers.

PHARMACOLOGICAL ACTION AND THERAPEUTIC USES.—No work of recent date has been done to find out the nature of the action of the active principles occurring in the drug. Its use as a therapeutic agent even in the indigenous systems of medicine has dwindled to a great extent owing to the fact that the

irritation produced by its application cannot be properly controlled and, more often than not, it over-shoots the desired mark. After the administration of Bhelo fruit for the treatment of piles, 32 patients developed hepatitis, albuminaria and generalised urticaria. Further study is necessary before it can be usefully employed in medicine.

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SIDA CORDIFOLIA Linn. (Malvaceæ)

VERN.—Sans.—*Bala*, *Batyalaka*; Hind.—*Kungyi*, *Khareti*, *Bariar*; Beng.—*Brela*, *Bala*; Mar.—*Chikana*; Punj.—*Simak*; Tel.—*Muttava*, *Chiribenda*.

S. cordifolia or 'bala' is considered to be one of the most valuable drugs in the Ayurvedic or Hindu medicine and has been largely used by the Hindu physicians from very ancient times. In the Tibbi or the Mohammedan medicine it was used for its aphrodisiac effects. A systematic study of the chemical composition and medicinal properties was made by the Departments of Pharmacology and Chemistry of the Calcutta School of Tropical Medicine.

The genus *Sida* belongs to the Malvaceæ family and the plants belonging to this group are known in Sanskrit by the general name 'bala'. There are some seven or eight species but Sanskrit writers make mention of five species of 'bala' under the name 'pancha bala'.

1. Bala—*S. cordifolia* Linn. (Fl. Br. Ind., I, 324; Fl. Ind., 517), 'brela'.
2. Mahabala—*S. rhombifolia* var. *rhomboidea* Roxb. (Fl. Br. Ind., I, 324; Fl. Ind., 517).
3. Nagbala—*S. spinosu* Linn. syn. *S. alba* and *alnifolia* Linn. (Fl. Ind., 516); 'pila' or 'peet berela', 'bon methi' (Beng.).
4. Atibala—*S. rhombifolia* Linn. (Fl. Br. Ind., I, 323); 'lal barila' or 'berela'.
5. Bala Phanijivika—*S. caprinifolia* Linn. syn. *S. acuta* Burn. and *S. lanceolata* Roxb. (Fl. Br. Ind., I, 323); 'pila' or 'peet berela'.

There is another species known to the Sanskrit writers as 'bhumibala'—*S. humilis* Willd. (Fl. Br. Ind., I, 322, Roxb. 516), or *S. veronicifolia*.

S. cordifolia Linn., also known as *S. herbacea* Micans, and *Rotundifolia* Cav., *S. althæifolia* Swartzs, known in English as country mallow, is a small herb which grows throughout the plains of India where the climate is damp. The seeds are called 'bijband'.

It is distributed throughout tropical and sub-tropical India and Ceylon growing wild along the roadside in the villages. It is a perennial undershrub with long branches, rooting at the nodes with scattered stellate hairs. The leaves are cordate, oblong, obtuse, crenate and very downy on both surfaces. The petioles are as large as the leaf, the stipules are linear measuring nearly half the length of the petiole. The peduncles occur near the flower, the lower one is distant and is longer than the petioles, and the upper one is very short. The flowers are small and white and appear during the rainy season in all species. The roots of the different species of *Sida* are 2 to 5 inches long, about $\frac{1}{2}$ inch in diameter and

the stock is woody and fibrous. The bark is of a light yellowish-brown colour. If properly cultivated, the plant may grow as big as hemp or jute plant and produces a strong fibre.

USES IN THE INDIGENOUS MEDICINES.—The roots, leaves and seeds are all used in medicine and have a slightly bitterish taste. The roots of all the species are regarded as cooling, astringent, stomachic and tonic. An infusion made from them is given in nervous and urinary diseases and also in disorders of the blood and bile. They are considered aromatic bitters having febrifuge, demulcent and diuretic properties. The seeds are considered to be aphrodisiac and are used in gonorrhoea, cystitis and are also given for colic and tenesmus. The leaves are used in ophthalmia. The root juice is used for healing wounds; the juice of the whole plant is also used in rheumatism and spermatorrhoea. Made into a paste with juice of palmyra tree it is applied locally in elephantiasis. A decoction of the root and ginger is given in intermittent and other fevers attended with shivering fits. The root-bark powder is given with milk and sugar in persons suffering from frequent micturition and leucorrhoea. In many nervous diseases, *e.g.* hemiplegia, facial paralysis, headache, etc., the root is used either by itself or in combination with asafoetida and rock salt. It is also given internally and an oil called 'bala-tāila' prepared from a strong decoction of the drug mixed with milk and sesame oil is used as external application. Mixed with 'makaradhwaja' and musk it is used as a cardiac tonic.

Besides the above medicinal properties, the plant is of great commercial value as it yields a fine white fibre, the cellulose content of which is 83 per cent. as against 75 per cent. in jute. In the opinion of many experts no fibre of modern times affords better hopes of success than *Sida* as a substitute for flax.

CHEMICAL COMPOSITION.—*S. cordifolia* was analysed many years ago (1890) and was said to contain asparagin. A perusal of the literature shows that no detailed or systematic study of the nature of the chemical constituents present in the plant has been carried out. The drug was analysed by Ghosh and Dutt (1930) and the following is a summary of the work: A preliminary examination showed the presence of alkaloids and a quantitative estimation showed their occurrence to the extent of 0.085 per cent. of the whole plant as an average of 5 analyses. The seeds were found to contain about 4 times more alkaloid than either the stems, roots or leaves. A systematic examination of the drug by extraction with different solvents showed the presence of the following: (1) fatty oil, phytosterol, mucins, potassium nitrate, resins, resin acids, etc., but no tannin or glycoside, (2) alkaloids to the extent of 0.085 per cent. The hydrochloride of the alkaloid occurs in colourless needles and is freely soluble in water but sparingly soluble in absolute alcohol. The main portion of the alkaloid was identified to be *ephedrine*, an alkaloid so far observed in the different varieties of *Ephedra* only. These two plants belong to entirely different divisions of the vegetable kingdom. The ephedras belong to the groups of Gymnosperms while *S. cordifolia* belongs to Angiosperms.

PHARMACOLOGICAL ACTION.—As the action of the ephedrine is well-known it is unnecessary to describe it here. It may be stated that it was owing to the close resemblance of the pharmacological action of the *Sida* alkaloid to ephedrine that suspicions were aroused that it may be the same alkaloid. This was confirmed later by chemical studies. Its use as a cardiac stimulant in the old Hindu medicine has thus a natural basis.

THERAPEUTIC USES.—The plant generally met with contains only small quantities of ephedrine, 0.085 per cent. in the whole plant and over 0.3 per cent. in the seeds. It is quite possible that by proper cultivation and collection the alkaloidal content could be increased. As the plant grows abundantly in the plains of India this may give an easily-obtainable crude material for manufacture of ephedrine. The ephedras generally grow in India in the hills, often difficult from point of view of transport, and for this reason the price of this useful alkaloid is very high. Further work on these lines is in progress.

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SKIMMIA LAUREOLA Sieb. & Zucc. (Rutaceæ)

VERN.—Kumaon.—*Gurlpata, Nchar*; Nepal.—*Chumlani*; Punj.—*Barru, Ncr, Shalangli*.

This plant is distributed throughout the temperate Himalayas from Kashmir in the north to Mishmi and Khasia mountains in the south-east. It is a common shrub in the Dehra Dun Hills. In Kashmir the plant grows in abundance as an undergrowth shrub in fir forests at elevations of 7,000 to 9,000 ft. above the sea level. The leaves are often used as an incense and burnt near small-pox patients for their supposed curative effects.

CHEMICAL COMPOSITION.—Some work has been done on the leaves of the Indian species of laureola by such workers as Roure Bertrand Fils (1925 and 1934) and Rajdhan (1930). These investigations have been confined mainly to the essential oil, which has been found to contain 13 per cent. of terpenes (β -phellandrene, less of *l*-pinene), about 63 per cent. of esters (mainly linalyl acetate), 18 per cent. of alcohols (linalool and probably some terpineol), azulene, an oil, $C_{15}H_{26}O_2$, bergapten, and traces of an aldehyde and ketone. The oil contains quite a large percentage of linalyl acetate which is the main constituent of lavender oil. Skimmia oil, therefore, has a possible application in perfumery and soap industry in place of lavender oil which is at present being imported into India in large quantities.

Further investigation of the leaves by the senior author and co-workers revealed that it contains 0.5 per cent. of an alkaloidal substance. The alkaloid was obtained in form of yellow rhombic octahedral crystals, m.p. 175-76°C. It was insoluble in petroleum ether, sparingly soluble in ether and cold absolute alcohol, soluble in hot alcohol and in chloroform. From the chemical and physical properties studied it is found that the alkaloid isolated is identical with the alkaloid skimmianine isolated earlier from *Skimmia japonica*. Chatterjee and Bhattacharya (1947) isolated three coumarines from the leaves; isopimpinellin, bergapten, umbelliferone m.p. 230°C. and a neutral compound, $C_{24}H_{32}O_8$, m.p. 258-60°C. which has been named laureoline. The bark of this species also contains the same constituents as the leaf.

PHARMACOLOGICAL ACTION.—Honda (1904) stated that the alkaloid could be dissolved in dilute mineral acids when present in excess and he probably carried out his experiments with the acid solution. We experienced difficulty in evaluating the pharmacological action. It was soluble in dilute hydrochloric acid when the acid was present in some excess. The reaction was near about of pH 1.3 and in trying to neutralize the solution further, the alkaloid was precipitated. The pharmacological action of this solution was tested on rabbits,

cats, and frogs. The action of the acid, however, was so predominant that it masked the action of the alkaloid to a great extent. Other salts of the alkaloid were tried but none of them yielded any more soluble neutral solution. With the present state of our knowledge, it is not, therefore, possible to ascribe any specific pharmacological action to this alkaloid. This plant has not been used much for medicinal purposes even as a household remedy. Its main interest lies in the essential oil with a fragrant smell which it contains and which could possibly be utilised in soap and cosmetic industries in this country in place of the expensive imported perfumes.

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SONNERATIA ACIDA Linn. (Lythraceæ)

Syn. *Sonneratia caseolaris* Engl.

This is a small tree not exceeding 15 ft. in height and has red flowers. It grows among mangrove areas flooded by the sea and is common in many parts of Bengal, in the Sunderbans and the Deccan peninsula. It is recommended in indigenous medicine as a poultice for application in sprains and swellings. The fermented juice is said to be useful in stopping haemorrhage. It would appear to be chiefly used as a household remedy in the areas in which it grows.

CHEMICAL COMPOSITION.—Siddiqui and Chaudhry (1950) isolated two distinct colouring matters from the dried wood of the plant, archin and archinin and also a colourless crystalline water soluble phenolic compound archicine.

Archin, $C_{15}H_{10}O_6$, m.p. $248^{\circ}C$. was obtained as orange red needles in 2.0 per cent. yield. *Archinin*, $C_{15}H_{20}O_4$, m.p. $197^{\circ}C$. was obtained as lemon yellow plates in 1.5 per cent. yield. Archicine, $C_{17}H_{14}O_{12}$, (prousinol) m.p. $257^{\circ}C$. was obtained as water soluble, colourless needles in 0.05 per cent. yield.

The pharmacological action of these compound has not been investigated. No proper clinical trials have been carried out.

Reference:—

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STEPHANIA GLABRA (Roxb.) Miers (Menispermaceæ)

VERN.—Dehra Dun.—*Purha*; Nepal.—*Barkulilahara, Nimilahara, Tambarki*.

This is a large climbing shrub with greenish yellow flowers and large tubers, sometimes a single tuber weighing as much as 30 Kg. It grows in tropical and temperate Himalayas ascending to an altitude of 7,000 ft. above the sea level from Sindh Eastward to the Khasia Hills and Pegu. There is a great deal of confusion with regard to the identity of *Stephania glabra* and *Stephania herondifolia* species as the various parts of the two plants are alike except for slight variations in the leaf lamina, according to a private communication from S. N. Bal of Botanical survey of India. The root is considered useful in the treatment of pulmonary

tuberculosis, asthma, dysentery, fevers and intestinal complaints. It is widely used by the hill tribes of Assam as a household remedy.

CHEMICAL COMPOSITION.—Siddiqui and Co-workers (1950) investigated the tubers of the plant and isolated three crystalline alkaloids which have been named gindarine, gindarinine and gindaricine: (1) Gindarine, $C_{21}H_{25}O_4N$, m.p. $147^\circ C.$, occurs as nitrate in the plant to the extent of 1.5 per cent. of the weight of air-dried tubers. (2) Gindarinine, $C_{17}H_{19}N(OCH_3)_4.HNO_3$, m.p. $248^\circ C.$, also occurs in the tubers in form of nitrate to the extent of 1.2 per cent. Both gindarine and gindarinine have been shown to be identical with tetrahydropalmitine and palmitine respectively. (3) Gindaricine, $C_{18}H_{19}O_3N$, m.p. $193^\circ C.$, is obtained as colourless silky needles in 0.12 per cent. yield from the tubers. Preliminary studies carried out by Osborn at Sir William Dunn School, Oxford show that gindarinine nitrate possesses definite antibiotic action against staphylococcus.

This plant and the active principles isolated from it deserve further attention. The subject of antibiotic substances occurring in plant is yet in the infancy and the workers in India can profitably turn to it.

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SYMPLOCOS RACEMOSA Roxb. (Symplocaceæ)

THE LODH TREE

VERN.—Assam.—*Bhomroti*, *Kaviang*; Beng.—*Lodh*; Bomb.—*Hura*, *Lodh*, *Lodhra*; Darj.—*Kaidai*, *Khoidai*, *Sungcn*; Eng.—*Californian*, *Cinchona*, *China nora*, *Lodh tree*; Guj.—*Lodar*; Hind.—*Lodh*; Kumaon.—*Lodh*; Mar.—*Lodh*, *Lodhra*; Nepal.—*Chamlani* N. W. P.—*Lodh*; Sans.—*Balabhadra*, *Balipriya*, *Bhillataru*, *Bhilli*, *Galava Hemapushpaka*, *Kandakilaka*, *Kandanila*, *Laktakarma*, *Shahara*, *Shaharalodhra*, *Shambara*, *Shavaraka*, *Shukla*, *Tilaka*, *Tiritaka*, *Vanarajhata*; Tel.—*Lodduga*, *Sabaramu*, *Sapara*; Urdu.—*Lodapathani*.

It is a small tree found very commonly in the plains and lower hills of Bengal, Assam and Burma. It is also found in the dry forests of the Chota Nagpur plateau up to an altitude of about 2,500 ft. above the sea level. The bark and leaves of this species are used in dyeing and a yellow dye is said to be extracted from both. In medicine the bark is chiefly used, and according to U. C. Dutt, it is a very good astringent and is useful in bowel complaints, eye diseases and ulcers. A decoction of the bark is used even to this day in villages as a gargle in spongy and bleeding gums. In Bombay the bark is often employed in the preparation of plasters and is supposed to promote resolution of inflammatory masses and exudates.

CHEMICAL COMPOSITION.—Hesse (1878) obtained from the bark three alkaloids (1) *loturine* 0.24 per cent., (2) *colloturine* 0.02 per cent. and (3) *loturidine* 0.06 per cent. Besides this, a large quantity of red colouring matter was also obtained. Later on, Späth showed that loturine was identical with abrine and harman.

THERAPEUTIC USES.—Alcoholic extracts and watery extracts of 'lodh' are very frequently used by the medical profession as astringents for looseness of the bowels. The bark-powder, in 20 grain doses thrice daily, has also been used in combination with 'bael' and 'kurchi' bark. In cases of chyluria and elephantiasis due to filarial infections, 'lodh' has been for some time past a favourite remedy with many physicians in the country. No definite statement with regard to its utility in medicine can be made unless further clinical and laboratory trials are carried out. At present its use is purely empirical.

References:—

- (1) Hesse, 1878, *Ber.*, 2, 1542; (2) Späth, 1920, *Monatsh. Chem.*, 41, 401.

TARAKTOGENOS KURZII King (Flacourtiaceæ)

VERN.—Assam.—*Lcmtam*; Burma.—*Kalanzo*, *Kalaw*, *Kalawaso*, *Kalawni*, *Kalawso*; Lepcha.—*Tukakunga*.

HYDNOCARPUS WIGHTIANA Blume. (Flacourtiaceæ)

VERN.—Bomb.—*Kadukavatha*, *Kauti*, *Kava*, *Kowti*; Dec.—*Janglibadam*; Mal.—*Koti*, *Maravetti*, *Maroti*, *Niralam*, *Nirvetti*, *Vetti*; Mar.—*Kadukavata*, *Kantel*, *Kastel*, *Kowti*; Sans.—*Garudaphala*; Tam.—*Maravattai*, *Niradimuttu*; Tel.—*Advibadamu*, *Niradi*; Tulu.—*Surantc*.

Chaulmoogra has been used in the Hindu medicine against leprosy for many centuries and during recent years it has come to be recognised in the Western medicine as a most valuable remedy in the treatment of this disease. In the Buddhistic literature of ten or more centuries ago, mention is made of the great improvement in the condition of the lepers after eating raw chaulmoogra seeds. There are records to show that the oil extracted from the seeds has been used in the treatment of leprosy and as a household remedy for many skin diseases since 1595. In the 'Makhzan-el-Adwiya,' one of the oldest books on Mohammedan materia medica, mention is made of the use of the seeds under the name of 'chaulmoogri'.

In the indigenous medicine the oil was orally administered mixed with clarified butter, the resultant mixture having a brownish yellow colour and the consistence of a soft ointment. The Western practitioners quickly appreciated the beneficial effects produced by this drug and began to use it in the very early days of British rule. In 1854, Mouat reported improvement in a case of leprosy as a result of oral administration and local application of chaulmoogra. In 1868, the curative effects of chaulmoogra were so well-known that it was made official in the Pharmacopoeia of India, the chief preparation being an ointment which was directed to be made from the pounded kernels mixed with 'unguentum simplex'. It was not till 1904, when Fredrick B. Power and his collaborators published in detail the chemistry of chaulmoogra oil, that the attention of the scientific world was drawn to this valuable drug.

The oil is obtained from *T. kurzii*, which is a tall, evergreen tree 40 to 50 ft. in height with lanceolate or oblong lanceolate leaves 7 to 10 inches in length. It grows in abundance in Eastern Bengal and the upper part of Burma and is distributed along the eastern and southern slopes of the Pegu, Yoma, Martaban, in the forests of Sylhet, Chittagong, etc. The fruits, which grow upon the stems and main branches of the tree are of the size of an orange and have numerous seeds embedded in the pulp. The oil is expressed from these seeds. The hill tribes in Sikkim use the pulp to poison fish and sometimes use it as a food also after boiling it with water. The bark of the tree is said to be used as a febrifuge; it contains large amounts of tannin and an infusion made from it has the odour of the essential oil of bitter almonds.

Besides *T. kurzii*, certain other trees belonging to the Flacourtiaceae family also yield oils having a composition closely akin to that of true chaulmoogra oil. *H. wightiana* is one of the most important members of this group. It grows abundantly in the western parts of the Peninsula from South Konkan along the coastal range. It is known by the name of 'kowti' in those parts and is a tall tree having a whitish wood. The fruit is globose, about the size of an apple, with a rough thick brown rind. Within the fruit there are from ten to twenty obtusely-angular seeds, $\frac{3}{4}$ inch in length embedded in a scanty white pulp firmly adherent to the thin black testa. When the pulp is peeled off, the outer surface of the testa is seen to be rough and striated by shallow longitudinal grooves. Inside the shell is a copious oily albumen, containing two large, plain, heart-shaped, leafy, cotyledons like those of chaulmoogra. The albumen when fresh is white but turns to a dark brown colour in the dry seeds; the odour resembles that of chaulmoogra.

H. anthelmintica is another member of the same family. This tree is indigenous to Siam, Northern Cochin and Gamboja. The seeds about 30 to 40 in number, are found in pods, which differ from chaulmoogra only in having a stronger testa. The seeds were exported to China from Siam under the name of 'dakrabo'. Recently, the native Chinese tree 'ta-feng-tzu' has been identified as *H. anthelmintica*. This tree grows extensively all over China and the fruits can be bought cheaply and plentifully at the wholesale drug fairs. Though its identity has only been recently discovered, it is interesting to note that the seeds are described in Chinese books, e.g., *Pen t' sas* (1590) as good for leprosy, itch, pityriasis, psoriasis, syphilis, lipoma, etc. There are several other species which have also been recognised as important sources of the oil. The names of the most important members with their habitat are stated below:

	Description	Habitat
<i>Hydnocarpus venenata</i>	Ceylon, Deccan and Burma
" <i>castanea</i>	" ..	Burma
" <i>anthelmintica</i>	" .	Siam, French Indo-China
" <i>curtisii</i>	Penang
" <i>hutchinsonii</i>	Philippine Islands
" <i>subfalcata</i>	" "
" <i>woodii</i>	India
" <i>alpina</i>	
<i>Asteriosigma macrocarpa</i>	Travancore
<i>Onchoba echinata</i>	Sierra Leone
<i>Carpotroche brasiliensis</i>	South America

In the older literature, it was believed that chaulmoogra oil was derived from the seeds of *Gynocardia odorata*. It was not till 1901 that Prain showed that true chaulmoogra oil was obtained from the seeds of *T. kurzii*, a tree grown in Assam and Burma.

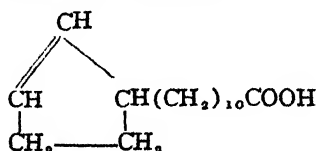
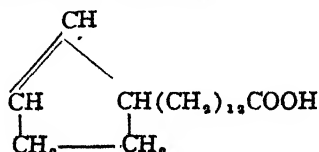
Gynocardia odorata is a native of Sikkim, Assam, and Chittagong in East Bengal. In Assam, an oil is sometimes expressed from it by the local people. The fruits as well as the seeds are very similar in appearance to those of *T. kurzii* and that is probably the reason for the confusion that existed for such a long time. The seeds of *T. kurzii* may, however, be distinguished by the fact that the radicle of the seed is terminal, while in *Gynocardia* seed it is lateral.

The chief sources of oil in India are *H. wightiana* and *T. kurzii*. *H. wightiana* grows in gardens and accessible places all over south India, so that seeds can be obtained quite fresh. *T. kurzii*, on the other hand, grows in out of the way places where its seeds cannot be gathered easily during the rainy season when the fruit falls, and in consequence, it is not easy to get fresh seeds for extraction of the oil. The oil derived from *H. wightiana* is, therefore, preferred to the other. Hydnocarpus oil is further considered to be superior on account of its higher rotation value (5.5 degrees higher than chaulmoogra oil).

CHEMICAL COMPOSITION.—Chaulmoogra oil is liquid at ordinary temperature and is of a pale yellow to a reddish brown colour with a somewhat acrid taste. The oil sold in the bazar is usually rancid and dark brown and devoid of therapeutic properties as it is usually expressed from old seeds. The seeds yield 30 to 40 per cent. of the oil according to the method of extraction used; by hydraulic pressure only 30.9 per cent. is obtained but by ether extraction method the quantity is increased to 38.1 per cent. The fatty oil obtained thereby has the following properties:

		Expressed Oil	Oil Extracted by Ether
Melting point	.....	22—23°C.	22—23°C.
Sp. gravity	.....	0.951 at 25°C.	0.952 at 25°C.
Acid value	.....	23.9	9.5
Saponification value	.....	213.0	208.0
Iodine value	.....	103.2	104.4
Specific rotation	.....	+52.0°	+51.3°

Power and his associates (1904) worked out the chemistry of chaulmoogra oil very exhaustively. They found that the oil consists chiefly of the glyceryl esters of two or more new fatty acids. The new acids isolated differ from any previously known fatty acids in containing a five-membered carbon ring with side chains of diminishing length as the molecular weight decreases. Further, these acids are unique in being optically active and dextro-rotatory. They contain only one pair of doubly-linked carbon atoms, hence they absorb but two halogen atoms. These acids were named 'chaulmoogric' and 'hydnocarpic' acids by the discoverers and it is probable that the specific bactericidal and medicinal properties of these acids are associated in some way with their molecular constitution. The constitutional formula is given below:

Hydnocarpic Acid, $C_{16}H_{28}O_2$ Chaulmoogric Acid, $C_{18}H_{32}O_2$ 

Besides the above mentioned acids, chaulmoogra oil contains a small amount of palmitic acid and, as Wrenshall and Dean (1924) have found, another highly unsaturated acid with an iodine number of 168.3.

The oil expressed from the fresh seeds of *Gynocardia odorata* was shown by Power and Barrowcliff (1905) to differ completely from chaulmoogra oil, both in its physical character and in its chemical composition. *Gynocardia* oil at ordinary temperatures is a pale yellow liquid having an odour resembling that of linseed oil. It is completely devoid of optical activity and contains the following constituents:—(1) linolic acid or isomerides of the same series, (2) palmitic acid in considerable amount, (3) linolenic and iso-linolenic acids, (4) oleic acid, (5) crystalline cyanogenetic glycoside, gynocardin. The specific unsaturated acids on which the action of chaulmoogra oil depends are not present in the *Gynocardia* oil.

In the Table XVII the characteristics of chaulmoogra and allied oils are given for comparative study.

PHARMACOLOGICAL ACTION.—Chaulmoogra oil itself has very little bactericidal property as it cannot easily penetrate the bacterial cell-wall. It possesses, however, a definite bacteriostatic action as is evidenced by the fact that addition of the oil (2 per cent.) to culture media inhibits the growth of acid-fast bacilli, such as tubercle bacilli. Derivatives of the oil, on the other hand, are more active. Sodium salts of the total fatty acids—chaulmoogrates—are said to possess a high degree of bactericidal and bacteriostatic activity against tubercle bacillus *in vitro* in such dilutions as 1 in 1,00,000. This action is said to be a specific one as it is

*TABLE XVII

	Specific gravity, 30°C. 30°C.	Refractive index 30 °D	Freezing point °C.	Rotation 100 mm. 30°/D	Iodine number hanus	Saponi- fication number	Fatty acid Specific rotatory power 30 [α] D
<i>Gynocardia odorata</i>	0.929	1.4743	4	0	160	198	0
<i>Hydnocarpus alcala</i>	0.948	1.4763	24	48.3	94.0	202	40
<i>Hydnocarpus anthelmintica</i>	0.952	1.4630	16	44.2	84.5	201	50
<i>Hydnocarpus venenata</i>	0.947	1.4769	20	46.4	90.7	191	49
<i>Hydnocarpus wightiana</i>	0.947	1.4763	11	51.2	97.0	207	54
<i>Taraktogenos kurzii</i>	0.951	1.4771	9	43.5	104	215	43
<i>Asteriostigma macrocarpa</i>	0.955	.....	.....	48.1	95.2	198	.....

* Modified from Perkins and Cruz, 1923.

not present in the case of such closely related fatty acids as those occurring in cod-liver oil, etc. Suspensions of virulent tubercle bacilli are said to be rendered harmless to guinea pigs by incubation for 48 hours with any of the acid sodium salts or the esters of the fatty acids of chaulmoogra oil. The esters are found to have no inhibitory effect on *Staphylococcus albus* and other allied organisms.

Chaulmoogra oil is extremely irritating by whichever route it is administered. Oral administration of 3 to 4 drops of the oil produces nausea and vomiting, but it is possible to develop a tolerance to it so that as much as 15 minims can be taken in a single dose. Not only the oil, but the sodium salts of the fatty acids as well as the esters have powerful irritant actions as well. The injection of these medicines into the tissues is painful and local abscesses may form. The systemic effects produced by chaulmoogra oil derivatives are not very marked.

THERAPEUTIC USES. *Administration of Chaulmoogra Seeds and Oil by the Oral Route.*—Chaulmoogra has long been used in India in certain skin diseases and particularly against leprotic lesions of the skin. Originally chaulmoogra seeds were given by the mouth, but this was found to be unsatisfactory and so the oil expressed from the seeds began to be used. Oral administration, of both the seeds and the oil produces nausea and vomiting and cannot be continued for a long time. It was, therefore, largely discarded in favour of the intramuscular and intravenous administration of the drug. Recently, however, oral administration has again been advocated by some physicians, particularly for those cases of leprosy which cannot attend the treatment centres regularly. Attempts have been made, therefore, to overcome the irritant action of the oil on the stomach by giving it in keratin-coated capsules, or as suggested by Denny (1929) by the addition of benzocaine. Travers (1926) in the Federated Malay States, has revived the old Chinese treatment which consists in giving 2 parts of the powdered whole nut of *H. anthelmintica* with 1 part of *Cannabis indica*. Wayson and Badger (1928) employed a preparation of the esters which can be given without inconvenience by the mouth. While it cannot be denied, in the light of the investigations carried out by de Aguiar Pupo (1926), Rodriguez (1925) and Lindow (1927), that the oral administration of chaulmoogra is definitely beneficial, it must be realised that it is very difficult to administer it in sufficiently large doses by this route and that a prolonged course of treatment which is essential for success is in many cases impossible.

CHAULMOOGRA OIL AND ETHYL ESTERS BY THE INTRAMUSCULAR ROUTE.—The next important step in the treatment was the administration of chaulmoogra oil by the intramuscular route. As the oil itself is very irritant, Mercado (1914) tried to produce a preparation which would prove less irritant to the tissues. He used a mixture of 60 c.c. of chaulmoogra oil, 60 c.c. of camphorated oil to deaden the pain and 4 gm. of resorcin as an antiseptic. Heiser (1914) treated a small series of cases with this mixture and reported 11.1 per cent. of apparent cures. This treatment has now been largely abandoned as patients refuse to submit to it on account of the pain it produces at the site of injection. In 1919, Dean prepared the ethyl esters of the total fatty acids of chaulmoogra. It is also evident from

the Report of the Leprosy Conference held in Calcutta in 1920 that in India, Sudhamoy Ghosh (independently of Dean) prepared the ethyl ester and suggested its use to Rogers. The injection of the ester of the pure acid, however, proved somewhat irritating to the tissues of the body and Rogers discontinued its use for some time. McDonald (1920) was, however, more successful and treated a number of cases with the ethyl esters of the entire fatty acids of the whole oil with 2 per cent. iodine by weight, chemically combined. The results which followed this method were very satisfactory and were unattended by pain and abscess formations. In India, Muir has largely used the ethyl esters. He has employed the following formula which has now become famous as the E. C. C. O. mixture: Mixed ethyl esters 30 c.c., pure creosote 30 c.c., camphor 30 gm. and olive oil 75 c.c. He prepares the esters in the following manner:

(1) HOT PROCESS: 425 gm. of crude cold-drawn hydnocarpus oil, 552 c.c. of 96 per cent. ethyl alcohol and 31.87 c.c. of sulphuric acid (sp. gr. 1.845) are placed in a 2½ litre flask fitted with a reflux condenser; the alcohol and oil are mixed before the acid is added. The contents are allowed to boil on a water bath for 24 hours without intermission. The reaction product is then transferred to a separating funnel and washed with water and then with 0.2 per cent. sodium carbonate solution; crystals of sodium chloride are then added gradually when the emulsion breaks up and esters rise to the surface.

(2) COLD PROCESS: This takes longer than the hot process, but has the advantage that no special apparatus is required and the labour is less. The oil, alcohol and the acid are mixed in the same proportions as in the hot process in a 4 lb. bottle with a tightly-fitting glass stopper and left until the process of esterification is complete. The bottle is shaken once or twice a day to mix up the upper with the lower layers and is kept in some warm place. It takes 2 to 3 weeks for the process to be completed. This method can be used in any ordinary leper institution. The weight of esters formed is almost equal to the weight of oil used.

The treatment with ethyl esters has now become very popular and has constituted the chief medicament in use in many leper institutions. It has been used to a considerable extent in China by Fowler (1922), Wilson (1924), Read and Feng (1925) and others. Some workers have preferred to add 25 per cent. of camphor to the mixture. A number of preparations of the ethyl esters are available in the market, the best known of these preparations being, 'moogrol' (British), 'antileprol' (German) 'antilebrine' (Italian).

SODIUM SALTS OF THE FATTY ACIDS OF CHAULMOOGRA AND HYDNOCARPUS OILS.—Rogers (1916) prepared the sodium salts of the fatty acids of chaulmoogra oil. These sodium salts were found to be freely soluble in water and their toxicity was also low so that they could be injected intravenously without any danger to the patients. Later, it was observed that salts of higher-melting fatty acids are more irritant and painful and Rogers attempting to do away with this drawback, advocated the use of the less irritating lower-melting fatty acids of the oil. 'Alepol' is a salt prepared from such an acid. This salt has also been held in high esteem by many leprosy experts.

Dikshit (1932) has studied the pharmacological action of this drug. Its toxicity is fairly low. A 3 per cent. solution introduced into the femoral vein of cats or dogs is lethal in doses of about 0.3 gm. per kilo of body weight. It has

a selective action on acid-fast bacteria and inhibits the growth of tubercle bacilli in concentrations as low as 1 in 200,000. It also exerts a toxic action on some helminths like the microfilaria of crows and tapeworms of cats. It has got a slight depressant action on the cardio-vascular system. Respiration is stimulated by small doses administered intravenously and the bronchioles are slightly dilated. The most important action is, however, on the erythrocytes. The soap has got marked haemolytic properties, but this action can be considerably lessened by dissolving the drug in Locke's solution and using Muir's expedient for giving intravenous injections. The latter consists in withdrawing blood in the syringe containing the dose, mixing and then injecting the whole quantity intravenously. This reduces the local action on the vessel endothelium and also diminishes the haemolytic action of the soap on the red blood cells.

From a study of the different methods of treatment, it is evident that chaulmoogra oil is really effective in the treatment of leprosy. The modern methods of treatment by employing the ethyl esters or sodium salts of the fatty acids appear to be distinctly better than the ordinary administration of the oil by the oral or the intramuscular route, though the latter methods are not devoid of therapeutic activity. The oil obtained on the market is very frequently mixed with gynocardia oil and linseed oil. Much of the discrepancy in the results obtained by various workers in the treatment of leprosy in the early periods can probably be accounted for by the badly adulterated oils they had to use. Chaulmoogra oil is costly and even now when large supplies are available there is great temptation for the retail dealers to mix cheaper oils with it. Owing to the extended use of the hydnocarpus oil at the present time, a good quality of the oil is now available on the market. Whenever there is any doubt as to the nature of the oil, it is always better to test its purity. Of all the tests, the specific rotation of polarised light is probably the best indication. The specific rotation of the oil from *H. wightiana* is 57.7° and that from *H. anthelmintica* 52.5°.

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TERMINALIA ARJUNA W. & A. (Combretaceæ)**ARJUNA**

VERN.—Assam.—*Orjun*; Beng.—*Arjun*, *Arjuna*, *Kahu*; Bomb.—*Anjan*, *Arjun*, *Arjunasadra*, *Jamla*, *Kowa*; C. P.—*Kahua*, *Kow*, *Kowah*, *Kowha*, *Saj*; Eng.—*White murdah*; Hind.—*Anjan*, *Anjani*, *Arjan*, *Arjuna*, *Jamla*, *Kahua*, *Kaugach*, *Khawa*, *Kowa*; Mar.—*Anjan*, *Arjun*, *Arjuna*, *Arjunladada*, *Azun*, *Sadura*, *Sanmadat*, *Savimadat*; N. W. P.—*Anjani*, *Arjan*; Punj.—*Arjan*, *Jumla*; Sans.—*Arjuna*, *Chitrayodhi*, *Dhananjaya*, *Dhanvi*, *Dhavala*, *Gandiri*, *Indradru*, *Indradruma*, *Karnari*, *Kaunteya*, *Krishnasarathi*, *Shambara*, *Shivamallaka*, *Vairantak*, *Vira*, *Viravriksha*; Tam.—*Attumarudu*, *Marudu*, *Nirmarudu*, *Vellaimarudu*; Urdu.—*Arjan*.

T. arjuna is a large deciduous tree attaining a height of 60 to 80 ft. It is common throughout the sub-Himalayan tracts of the Uttar Pradesh and in the Deccan, southern Bihar, Chota Nagpur, Burma and Ceylon. The bark is considered by the Sanskrit writers to be a cardiac tonic. Vagbhatta was the first to prescribe the bark of 'arjuna' in heart disease. Later, Chakradatta the great Hindu physician, described it as a tonic and astringent, and used it in heart disease. He recommended it to be given as a decoction with milk and treacle water or as a 'ghrita' (preparation with ghee or melted butter) made with the decoction or powder of the bark. The bark and preparations made from it are reputed to have a marked stimulant action on the heart even to the present day in this country. The practitioners of Hindu medicine use them for all sorts of conditions of cardiac failure and dropsy. Some of the practitioners of Western medicine believe in its stimulant effect on the heart and use it as a cardiac tonic. A liquid extract prepared from the bark is on the market in Calcutta.

CHEMICAL COMPOSITION.—A reference to the literature shows that this drug has interested many previous investigators. According to Hooper (1891) the bark yields 34 per cent. of ash consisting almost entirely of pure calcium carbonate; the watery extract contains as much as 23 per cent. of calcium salts and 16 per cent. of tannins. Very little colouring matter besides the tannin is extracted by alcohol. Ghoshal (1909) made a detailed chemical and pharmacological study of the bark. He found it to contain the following substance.—(1) sugar, (2) tannin, (3) colouring matter, (4) a body of the nature of a glycoside and (5) carbonates of calcium and sodium and traces of chlorides of alkali metals. He also found that the total tannin content amounted to 12 per cent. and the content of ash to 30 per cent. The author and his co-workers obtained good specimens of the bark and made a careful analysis with a view to finding out the active principles which might be responsible for the alleged stimulant action of the drug on the heart. As the drug is said to contain glycosides, a very careful search was made for this presence. Neither alkaloid nor glycoside could be found in the bark and there was no substance of the nature of an essential oil. The bark contains the following substances:

- (1) Unusually large quantities of calcium salts with small amounts of aluminium and magnesium salts.
- (2) About 12 per cent. of tannins, consisting mainly of pyrocatechol tannins.
- (3) An organic acid with a high melting point and a phytosterol.
- (4) An organic ester easily hydrolysed by mineral acids.
- (5) Some colouring matters, sugars, etc.

It will be seen that the analysis of the bark of *T. arjuna* does not reveal the presence of active principles which could account for its cardiac-tonic effects so widely believed in this country. The different fractions obtained from petroleum ether, alcoholic and aqueous extracts during analysis were carefully tested but, with the exception of calcium compounds, no other constituent producing any effect on the heart or on any of the other tissues were detected. The colouring matter was separated and tested with the same result. Dutt and co-workers (1935) investigated the bark for active principle responsible for the long use as diuretic and tonic. A colourless crystalline compound arjunin, $C_{26}H_{32}O_3$, was obtained. It is an acid (m.p. $192^\circ\text{C}.$) and is probably an aglucon of the glycoside present in the plant. They also isolated from the alcoholic extract a red amorphous colouring matter (m.p. $132^\circ\text{C}.$) arjunctine, $C_{11}H_{18}O_4H_2O$ (m.p. $215^\circ\text{C}.$) and reducing sugars. Arjunctine was shown to be a derivative of hexahydrobenzene. Caius, Mhaskar and Isaac (1930) have studied in detail the chemical composition of the common Indian species of the genus Terminalia. They were unable to find any active constituent of the nature of an alkaloid or glycoside or an essential oil. All the fifteen specimens of barks examined gave when incinerated a white, soft odourless and tasteless ash. Except for the presence of iron in *T. pyrifolia* and *T. travancorensis* the composition of the ash is fairly constant. The mineral constituents of the barks of the different species of Terminalia are shown in Table XVIII.

TABLE XVIII

Showing Mineral Constituents per cent. of Bark of the Terminaliac

	CaO	CO ₂	MgO	P ₂ O ₅	SO ₃	Cl	K ₂ O	Na ₂ O	Fe ₂ O ₃	SiO ₂
1. <i>T. arjuna</i>	14.995	10.602	0.280	1.065	0.119	0.220	1.017	....	...	0.051
2. <i>T. bialata</i>	14.861	10.256	0.273	1.093	0.102	0.043	0.346	.. ..	.....	0.080
3. <i>T. belerica</i>	14.046	10.242	0.782	1.218	0.124	0.835	0.789	0.485	.. ..	0.158
4. <i>T. tomentosa</i>	12.012	8.253	0.484	0.953	0.061	0.286	0.256	.....	....	0.089
5. <i>T. manii</i>	11.823	7.927	0.494	0.923	0.112	0.091	0.256	.. ..	...	0.076
6. <i>T. myriocarpa</i>	10.363	8.673	0.226	0.702	0.081	0.036	0.354	0.218	.....	0.058
7. <i>T. chebula</i>	10.244	8.302	0.557	0.870	0.058	0.188	0.425	.....	.. ..	0.366
8. <i>T. catappa</i>	7.511	5.579	0.501	0.854	0.340	0.492	0.587	0.364	.....	0.031
9. <i>T. travancorensis</i>	7.062	4.930	0.332	0.627	0.068	0.043	0.194	.....	0.003	0.107
10. <i>T. pyrifolia</i>	6.741	4.843	0.313	0.632	0.069	0.029	0.210	....	0.042	0.132
11. <i>T. oliveri</i>	6.663	4.389	0.265	0.519	0.048	0.008	0.022	.....	.. ..	0.011
12. <i>T. pallida</i>	5.589	3.636	0.434	0.391	0.139	0.017	0.282	.....	.....	0.080
13. <i>T. citrina</i>	5.147	3.635	0.089	0.023	0.069	0.016	0.127	....	.....	0.047
14. <i>T. coriacea</i>	4.666	2.953	0.190	0.447	0.171	0.040	0.066	.....	.....	0.021
15. <i>T. paniculata</i>	4.427	2.806	0.213	0.459	0.146	0.019	0.073	.....	.....	0.078

Ghosh investigated the bark of *T. arjuna* and obtained 13.2 per cent. of ash of which 11.5 per cent. was soluble in acid and 1.9 per cent. was insoluble. The ash showed the presence of sulphate, silica, calcium, strontium, magnesium, iron,

aluminium and sodium. He showed the presence of both alkaloidal and glycosidal substances. These active principles in small doses stimulate the force of contraction of frog's heart (*in situ*), this increase in amplitude of contraction is associated with slight or no corresponding increase of the rate generally. In increasing the doses the increase in amplitude of contraction is maintained, when the limit is reached the heart becomes slow and the rhythm is altered.

Occasionally there is a pause between a series of regular contractions; subsequently the pause lengthens and the ventricle stops beating for a short period due to lowering of auriculo-ventricular conductivity. However, this blocking effect passes off gradually. In continuous perfusion experiments the blocking is persistent and the heart ultimately stops in systole. With isolated guinea-pig's as well as cat's heart the effect is more or less similar, i.e., increased ventricular systole. But generally the slowing and the blocking effects are manifest than the initial transient increase in amplitude of the ventricular contractions.

THERAPEUTIC USES.—Koman (1919-20) administered a decoction of the bark in 20 cases of valvular diseases of the heart and came to the conclusion that the drug was not useful. An alcoholic extract prepared from the bark was carefully tested at the School of Tropical Medicine in a number of patients suffering from failure of cardiac compensation with or without dropsy. In none of the patients did the drug produced any marked effects such as are produced by drugs of the digitalis or caffeine groups. The frequency and force of the heart beat and the blood pressure remained appreciably unaltered. The secretion of urine was not markedly affected in these cases. Any therapeutic effects attributed to the drug may be accounted for by the high calcium content to which reference has already been made.

Caius, Mhaskar and Isaacs (1930) have, however, reported that the dried barks of the Indian species of genus *Terminalia* exhibit a very great variability of forms. There are as many as 15 different varieties (see Table XVIII). The barks of these varieties of *Terminalia* are so very similar in appearance that there is very great likelihood of their being mistaken for one another. In India, practically no distinction is made by the drug-sellers between these varieties and all of them are being constantly exhibited and sold indiscriminately as 'arjuna'. These workers have studied the pharmacological actions of all the barks separately, using hot infusion, decoction and alcoholic extracts of the dried and cleaned bark. The conclusions are given below: "The pharmacologically-active barks of the commoner Indian species of *Terminalia* are either (i) mild diuretics, *T. arjuna*, *T. belerica*, *T. pallida*, or (ii) fairly potent cardiac stimulants, *T. bialata*, *T. coriacea*, *T. pyrifolia*, or (iii) both diuretic and cardiotonic, *T. catappa*, *T. chebula*, *T. citrina*, *T. myriocarpa*, *T. oliveri*, *T. paniculata*, *T. tomentosa*.

These conclusions are different from those reported from the Calcutta School of Tropical Medicine. As no active constituent has so far been isolated and as there is practically no change in the chemical composition of the different barks referred to by Caius and his co-workers it is difficult to conceive how the different

varieties reveal quite different pharmacological and therapeutic effects. The use of alcoholic extracts in pharmacological experiments brings in a lot of abnormal factors which are likely to vitiate the results. Further study is necessary to confirm the findings already recorded.

References:—

(1) Ghoshal, L. M., 1909, *Thesis on Terminalia arjuna*; (2) Koman, 1919-20, *Report on the Investigation of Indigenous Drugs*, Madras; (3) Chopra, R. N., and Ghosh, S., 1929, *Ind. Med. Gaz.*, 64, 70; (4) Caius, J. F., Mhaskar, K. S., and Isaacs, M., 1930, *Ind. Med. Res. Memoirs.*, No. 16 March; (5) Aggarwal, R. R., and Dutt, S., 1935, 1936, *Proc. Nat. Acad. Sci.*, 1935, 50, 1936, 305; (6) Ghosh, B. N., 1953, School of Tropical Medicine, Calcutta (Private communication).

THALICTRUM FOLIOLOSUM DC. (*Ranunculaceæ*)

VERN.—Arab.—*Mamiranchini*; Beng.—*Gurbiani*; Bomb.—*Mamiran*; Hind.—*Mamira*; Kash.—*Chaitra*; Kumaon.—*Barmat*, *Penglajari*, *Pilajari*; Pers.—*Mami-ranchini*; Punj.—*Chircta*, *Chitramul*, *Gurbiani*, *Kcraita*, *Mamira*, *Pashmaran*, *Phalijari*.

It is an erect rigid perennial herb found in the temperate Himalaya at altitudes of 5,000 to 8,000 ft. above the sea level and in the Khasia hills between the altitudes of 4,000 and 6,000 ft. It is a popular remedy in the Unani or Tibbi medicine and is considered as a bitter, pungent tonic with a slight purgative action. It is said to clear the brain and is used as a collyrium in Ophthalmia. It is believed to improve the eyesight and relieve tooth ache. It is useful in acute diarrhoea and is a good application in piles, nail troubles and discoloration of the skin. The root combines both the tonic and aperient properties. It has been considered useful in convalescence after acute diseases, in mild forms of intermittent fevers and as tonic in dyspepsia. The root is largely used as an anjan or application for ophthalmia in Afghanistan and throughout India. In the Punjab the root is used as a household remedy as a purgative and a diuretic. Though the root is considered to be a tonic and laxative and a good substitute for rhubarb, it is chiefly used in the indigenous medicine as a cheap but valuable substitute for mamira (*Coptis tecta*) in the preparation of Collyriums for eye troubles.

CHEMICAL COMPOSITION.—Dymock mentions in *Pharmacographia Indica* that thalictrum contains a large quantity of berberine so combined as to be readily soluble in water. Siddiqui (1941) investigated the drug and obtained two alkaloids, berberine and thalictrine. The presence of yet another base was also indicated but the quantity present was not sufficient for detailed examination. The yield of berberine is 0.2 per cent. on the weight of the dry powdered drug. Thalictrine, $C_{20}H_{27}O_4N$, m.p. $208^{\circ}C$. (yield 0.2 per cent.) is a new quaternary ammonium base which crystallises from methanol with the molecules of water crystallisation which it completely loses in vacuum at $100^{\circ}C$. The rhizomes are appreciably hygroscopic in character and do not stock well. After storage for about six months the quantity of berberine hydroiodide was reduced to nearly a quarter, while thalictrine could be obtained only in traces. Chatterjee and co-workers (1952) investigated the rhizomes which yielded berberine (0.35 per cent.), palmatine (0.03 per cent.), jatrorrhizine (0.02 per cent.) and no thalictrine as was reported earlier. Thalictrine most probably is a mixture of palmatine and phenolic base jatrorrhizine.

A few plants containing berberine have been used as house-hold remedies in the treatment of conjunctivitis, inflammation of cornea, and in form of a collyrium generally. Their chief use is considered to be rather preventive than curative. No proper investigation to prove or disprove these beliefs have been carried out.

References:—

(1) Dymock, Warden and Hooper, 1894, *Pharmacographia Indica*, 1, 33; (2) Sharma, V. N., and Siddiqui, S., 1941, *Jour. Ind. Chem. Soc.*, 641; (3) Chatterjee, R., Gupta, M. P., and Chatterjee, A., 1952, *Jour. Ind. Chem. Soc.*, 371.

THEVETIA NERIIFOLIA Juss. (Apocynaceæ)

THE EXILE; YELLOW OLEANDER

VERN.—Beng.—*Chinakarab*, *Kokilphul*, *Kolkaphul*; Bomb.—*Pilakaner*, *Pilvalakaner*, *Zardkunc*; Eng.—*Bastard oleander*, *Exile oleander*, *Yellow oleander*; Hind.—*Kaner*, *Pila*, *Pilakanir*, *Zardkunc*; Mad.—*Manjalalari*; Mal.—*Pachchaarali*; Mar.—*Pivalakanhera*; Sans.—*Ashvaghna*, *Ashvaha*, *Ashvamaraka*, *Ashvanashaka*, *Chandata*, *Divyapushpa*, *Gauripushpa*, *Haripriya*, *Hayamara*, *Hayari*, *Karavira*, *Kunda*, *Nakharavha*, *Shankudra*, *Shatakunda*, *Turangari*, *Vira*, *Viraka*; Tam.—*Pachaiyalari*, *Tiruvachippu*; Tel.—*Pachchaganceru*; West Indies.—*Abia de matto*.

The oleander tree is very commonly met with in the plains all over India and is widely grown in gardens for its beautiful yellow flowers. It is originally a native of the West Indies but has been completely naturalised in India. It is about 12 ft. high with large yellow bell-shaped flowers and linear lanceolate leaves. All parts of the plant abound in milky juice. The fruits are globular, light green, about 1½ in. to 2 in. in diameter and contain a single nut, light brown in colour and of a peculiar triangular shape. Each nut contains two pale yellow seeds. The seeds have long been known to be highly poisonous and have been very commonly used for suicidal and homicidal purposes. As an abortifacient, the seeds have also been used by women in Bengal and neighbouring provinces. Of late, the seeds have come into somewhat extensive use in some parts of the Bombay Presidency as a cattle poison.

CHEMICAL COMPOSITION.—De Vry Tijdschr has obtained from the kernel of the seed 57 per cent. of a limpid, almost colourless oil with a density of 0.9148 at 25°C and a solidifying point of 13°C. This oil yields on further extraction, a beautiful crystalline white glycoside to which is given the name of *thevetin*. The presence of the same glycoside but to a much lesser extent—4 per cent.—is also recorded by him in the seeds. Warden refers to a principle in the seed which gives a blue colour with hydrochloric acid and another toxic body which is much more powerful than the thevetin of De Vry Tijdschr. Recently (1919), a more detailed study of the glycoside of *T. neriifolia* has been carried out by B. De of the Madras Presidency College (unpublished). The glycoside thevetin was isolated by him in crystals melting at 189-190°C. On hydrolysis, the glycoside breaks up into glucose and an amorphous product which has been named *thevetidine*. Investigations carried out in the Chemical Laboratory of the Calcutta School of Tropical Medicine on the chemical composition of the seeds of Yellow Oleander, confirm the findings of De. The melting point of the glycoside has been found

to be 189-190°C. It is sparingly soluble in cold water but fairly soluble in hot water. It is freely soluble in dilute alcohol (50 per cent.) but insoluble in ether, chloroform, etc.

Ghatak (1932) extracted the air dried kernels with light petroleum ether and obtained 68.7 per cent. of a non-drying oil. From the fat free kernels with alcohol, he isolated thevetin, $C_{20}H_{30}O_6$, m.p. 192°C. It is a glycoside which yields on hydrolysis, glucose and thevetigenin, m.p. 83°C. From the mother liquor he isolated thevetoxin, $C_{14}H_{24}O_8$, m.p. 178°C. Thevetin is tasteless and nontoxic while the latter is bitter and very toxic. From the roots by extraction with boiling alcohol, he isolated thevetine, $C_{48}H_{86}$, m.p. 79-80°C., a wax, little oil and the glycoside thevetin, m.p. 192°C. After removal of these from the residue by treatment with lead acetate, tannic acid, barium hydroxide, and carbon dioxide, a liquid is obtained which on treatment with hydrochloric acid gave a compound neriifolium, $C_{30}H_{46}O_8$, m.p. 208°C. Chen (1934) isolated from the kernels of the nuts a number of compounds, a phytosterolin, $C_{27}H_{45}OC_6H_{11}O_5$, m.p. 291-2.5°C., ahouain, $C_{10}H_{19}O_{10}$, which softens at 94-5°C., foams at 112°C. and decomposes at 185°C., kokilphin, $C_{33}H_{61}O_{30}$, m.p. 188.5 to 189°C. and thevetin, $C_{20}H_{46}O_{13.2}H_2O$, m.p. 193°C. The data reported on thevetin do not correspond with those previously reported. Thevetin showed digitalis like action, is 1/8 times at potent as an equal weight of ouabain. The action of kokilphin and ahouain was very slight.

PHARMACOLOGICAL ACTION.—A preliminary study of the glycoside has been conducted by Chopra and Mukerji (unpublished). A watery solution of the drug is readily absorbed from the tissues and does not set up any marked local irritation. The glycoside is not toxic to unicellular organisms such as *P. caudatum* or multicellular organisms like the helminths. Frogs show definite signs of poisoning, the heart slows down and ultimately stops in systole. Higher animals such as the cat tolerate the drug very badly and die within two hours after the administration of the drug in dosage of 0.2 gm. per kilo. of body weight. The heart muscle seems to be affected most and death occurs in diastole from fibrillation of the ventricles. After small doses the systemic blood pressure shows a temporary rise when the drug is injected intravenously but, with the increase in dosage, irregularity in the blood pressure is evident probably on account of the early onset of delirium cordis.

THERAPEUTIC USES.—As has been already said *T. neriifolia* has not been used to any extent in therapeutics on account of its poisonous properties. In the Ayurvedic practice, a tincture of the bark (1 in 5) has been used as an antiperiodic. It is risky to use it as it is very difficult to arrive at the safe dosage without stepping into the toxic limit. The glycoside contained in the seeds has a powerful effect on the cardiac musculature.

References:—

(1) Chen, K. K., and Ling Chen, A., 1934, *J. Biol. Chem.*, 105, 231; (2) Ghatak, N., and Pendse, G. P., *Bull. Acad. Sci.*, 1932, 79, 1933, 259.

TINOSPORA CORDIFOLIA (Willd.) Miers (Menispermaceæ)

VERN.—Arab.—*Gilo*; Beng.—*Gadancha*, *Giloe*, *Gulancha*, *Guluncha*, *Nimgilo*; Bomb.—*Ambarvel*, *Gharol*, *Girol*, *Guloe*, *Gulwel*; Burma.—*Singomone*, *Sinzamanne*; C. P.—*Gulwel*; Dec.—*Gulbel*, *Gulo*, *Gulwel*; Guj.—*Gado*, *Galo*, *Gulo*, *Gulwel*; Hansot.—*Galavel*; Hind.—*Giloe*,

Gulancha, Gulbel, Gurach, Gurcha; Kathiawar.—*Galo, Galonovelo*; Kumaon.—*Gulancha, Gurcha*; Mal.—*Amrytu, Peyamrytam, Sitamrytu*; Mar.—*Ambervel, Gharol, Giroli, Gulavela, Gulavel, Guloc, Gulvel*; Nepal.—*Garjo*; Pers.—*Gulbel*; Punj.—*Batindu, Garham, Garum, Gilo, Gilogularich, Zakhmihaiyat*; Sans.—*Amrita, Amritalata, Amritavallari, Amritavalli, Bhishakapriya, Chakralakshana, Chakrangi, Chandrasasa, Chandrapasa, Chchinna, Chchinnaruha, Chchin-nodbava, Chchinnodhana, Dhira, Guduchi, Jivanthika, Jivantiha, Madhuparni, Madhuparnika, Pittaghi, Shyama*; Tan.—*Amridavalli, Kaipruchindil, Niraidarudian, Parivai, Padalamulam*; Tel.—*Duyutige, Guduchi, Somida, Tellatippatige, Tcppatige*; Tulu.—*Amrytaburu*; Kash.—*Bark, Bekhgillo*; Sind.—*Sutgilo*.

This is a glabrous, succulent, climbing shrub, often attaining a great height and sending down long thread-like aerial roots. The plant seems to be particularly fond of climbing up the trunks of large neem trees in the Uttar Pradesh. The bark is gray or creamy-white in colour, deeply cleft with spiral and longitudinal clefts, the space between the clefts being usually dotted with large rosette-like lenticels. The wood is white, soft and porous and the freshly cut surface soon assumes a yellow tint on exposure to air. The branches bear smooth heart-shaped leaves and bunches of red berries. The sap is viscous and light yellow in colour having a peculiar slimy odour and a nauseating bitter taste. Practitioners of Tibbi medicine consider it to be cooling and sedative. The fresh plant is said to be more efficacious than the dry. It is given with milk in rheumatism, hyperacidity of the urine and dyspepsia. The dry stem can be seen in every drug shop and from it is prepared a kind of starch known in Hindustani as 'Guloc-ka-sat' and in some parts of India as 'Pilo'. It is prepared by powdering the stem and washing out the starch with water, the latter generally always retaining a little of the bitterness of the drug.

T. cordifolia attracted the attention of European medical men in India and has been favourably spoken of by them as a tonic, antiperiodic and diuretic. The drug itself as well as a tincture prepared from it are now official in the Indian Pharmacopoeia. The medicinal properties of the plant have been ascribed by various authors as being due to the presence of berberine, without any isolation or identification of the alkaloid in the plant. It is stated to be effective in chronic diarrhoea and some forms of chronic dysentery. It was prescribed with benefit by ancient Hindu physicians in gonorrhoea. It is also regarded by the inhabitants of some parts of India as an antidote against the bites of poisonous snakes and insects but this has not been substantiated.

CHEMICAL COMPOSITION.—The stems of the plant were examined by Flückiger (1884) by boiling with alcohol and a little hydrate of calcium, evaporating off the alcohol and extracting the residue with chloroform. The chloroform extract responded to tests for alkaloids. It was yellow in colour from which, probably, the author concluded that the plant contained berberine. The alcoholic extract, after it has been exhausted with chloroform as stated above, was dissolved in boiling water and precipitated with tannic acid. The precipitate thus obtained was mixed with moist lead carbonate, dried and exhausted with

alcohol which, on evaporation, yielded the bitter principle. By boiling this bitter principle with dilute sulphuric acid, sugar was produced and the substance lost its bitterness. Neither the original bitter principle nor the product derived from hydrolysis could be crystallised or obtained in sufficiently purified form. Pendse and Dutt (1932) definitely ascertained the presence of an alkaloid in the plant by taking the alcoholic extract and treating it with acidulated water and testing the solution with the usual alkaloidal reagents. All these, however, gave colour reactions or precipitates which were very different from those given by berberine. Extractions of the drug with various solvents gave nothing very interesting except chlorophyll, sugars, some resins and waxes. The bitter principle in the plant was also obtained in a semi-solid form and it could not be crystallised.

Bhide and co-workers (1941) investigated the stems of the plant reared on the mango tree or cactus in the Western Ghats. They isolated from the alcoholic extract two bitter substances A and B and a neutral substance. The bitter substance A possesses molecular formula, $C_{22}H_{34}I_{10.5}H_2O$, m.p. $226-8^{\circ}C$ and is found to the extent of 0.1 per cent. in the stem. Bitter principle B is not a glycoside and has molecular weight of 475 and melts at $186-8^{\circ}C$. The neutral substance has molecular formula $C_{28}H_{50}O$ and molecular weight 415 and melts at $82-3^{\circ}C$. It appears to be Octacosanol. Jois (1941) isolated from the plant three substances melting at $75-7^{\circ}C$, $83-4^{\circ}C$. and $181^{\circ}C$. respectively. The first two may have been more or less pure neutral substances and third was perhaps the bitter substance B isolated by Bhide and co-workers. He could not isolate the bitter substance A. The difference may possibly have been due to the fact that his material was not reared on mango tree. These authors found that the above mentioned principles could not be obtained from plants reared on neem trees. In view of the great importance attached to Giloe in the indigenous medicine and the varied claims put forward by various authors with regard to its active principles, Siddiqui (1949) reinvestigated the stems and obtained the following crystalline substances: (1) Giloin, $C_{23}H_{32}O_{10}H_{20}$, a glycoside, m.p. $226-28^{\circ}C$ after drying to a constant wt. over P_2O_5 , yield 0.2 per cent. It is bitter in dilution of 1 in 10,000. (2) Gilenin $C_{17}H_{18}O_5$, a non-glycoside bitter m.p. $210-12^{\circ}C$, yield 0.001 per cent. and bitter in dilution of 1 in 1,000. (3) Gilo sterol, $C_{28}H_{48}O$, m.p. $192-93^{\circ}C$.

In spite of the fact that this plant is so extensively used as a household remedy and also by the Tibbi practitioners and much chemical work has been done, the pharmacological action of the active principles isolated has not been worked out. Efforts have not also been made to carry out clinical trials with a view to determine its effectiveness in dyspepsia and other conditions. Probably any therapeutic effects it possesses are due to the bitter principles contained in the plant.

References:—

- (1) Flückiger, Dymock, Warden and Hooper, 1894, *Pharm. Indica*, 1, 56; (2) Pendse, and Dutt, 1932, *Ind. J. Med. Res.*, 20, 663; (3) Subba Jois, 1941, *Proc. Ind. Sci. Congress* 111, 93; (4) Bhide, Phalinikar, and Pranipe, 1941, *J. Univ. Bombay*, 10, 89; (5) Kidwai, Salooja, Sharma, and Siddiqui, 1949, *Jr. Sci. Ind. Res.*, 115.

TODDALIA ACULEATA Pers. (Rutaceæ)

VERN.—Sans.—*Kanchana*; Hind.—*Kanj*; Beng.—*Kada-todali*; Rajput.—*Dahan, Lahan*; Nepal.—*Meinkara*; Tam.—*Milkarana*; Tel.—*Konda-kahinda*; Bomb.—*Jun-li-kali-mirchi*.

T. aculeata is a large scandent shrub found in the Nilgiris and in the sub-tropical Himalayas from Kumaon eastwards to Bhutan, ascending to 5,000 ft. above the sea level. This plant early attracted attention as perhaps one of the most valuable of Indian medicinal products. The root bark has been particularly extolled

as a potent anti-malarial remedy. It was stated by several prominent physicians in those days to possess an antiperiodic and antipyretic effect, equal to, if not superior to, quinine and other alkaloids of cinchona. The root bark as well as the fresh plant has an aromatic odour and was used in the European medicine under the name of Lopez root. It was also included in the Pharmacopocia of India.

CHEMICAL COMPOSITION.—The leaves, on distillation, yield an essential oil with a sharp aromatic odour. Detailed analysis shows that the chief constituent is a camphor-like body with a melting point of 96.5-97°. Citronellal and linalool are also present. The root bark contains an essential oil, resin, a bitter substance, citric acid, pectin, starch, etc., but the chief constituent is berberine which, however, is present only in small quantities. Perkin and Hummel (1937) found that the chief alkaloid present in the plant is berberine, but contrary to their findings Dey and Pillay (1935) found that it contains two alkaloids, codaline, a tertiary colourless, monoacid base, $C_{21}H_{21}NO_4$, m.p. 269-70°C., totally insoluble in hot water in contrast to both modifications for berberine, almost insoluble in absolute alcohol. The other alkaloid totalinine, $C_{19}H_{15}O_4N \cdot 0.05H_2O$, m.p. 180-200°C. (decomp.) is very strong base passing readily on manipulation of its hydrochloride into an isomeric non-basic substance of like composition. Both alkaloids are apparently closely related and probably belong among the alkaloids of berberine group. The yield of totaline was 0.1 to 0.12 per cent., totalinine 0.1, lactone 0.8 with formula $C_{16}H_{20}O$ occurring in rhombic prisms, m.p. 132-133.5°C, resin 7.0, glycoside (crude) 0.8, fatty oil 3.0, lac like substance 0.1 per cent.

PHARMACOLOGICAL ACTION.—An attempt was made by Vyas and Bhatia (1932) to find out if a freshly-prepared infusion of Toddalia has any toxic effect on unicellular organisms such as paramoecia. Their results show that the drug is only very feebly toxic, the toxicity being about one-fifth of that of cinchona. Dey and co-workers investigated the pharmacological action of the alkaloid totaline and found that it has no antipyretic effect. It is irritant to the mucous membranes and subcutaneous tissues. It has no action on the heart but small doses raise the blood pressure. The plain muscle of the bronchi, blood vessels, intestines, spleen and the bladder are all stimulated to contraction. Skeletal muscle immersed in a 5 per cent. solution shows a marked increase in tone. The load lifting power of skeletal muscle is increased. A marked increase in the salivary secretion is also produced.

THERAPEUTIC USES.—The alleged anti-malarial properties of the root bark have recently been tested by Vyas and Bhatia in the hospitals of the King George's Medical College, Lucknow (1932). They used a tincture of the root bark in $\frac{1}{2}$ to 1 drachm doses. Out of 26 cases of proved malaria treated with Toddalia mixture, 23 cases showed a persistent presence of the parasites even on repeated blood examinations. The symptoms appeared to have abated in only a small proportion of the cases (3 cases) which might also happen even when no treatment is given. These workers conclude that the alcoholic extract of Toddalia prepared from the root bark has no effect on the clinical symptoms or on the malaria parasites present in the blood of patients.

References:—

- (1) Report, 1893, Schimmel & Co., April, 64;
- (2) Perkin and Hummel, *J. C. S.*, 1895, 413;
- (3) Vyas and Bhatia, 1932, *Ind. Med. Gaz.*, 192;
- (4) Dey, B. B., Pillay, P. P., 1933, *Arch. Pharm. Berl.*, 477;
- (5) Dey, B. B., Pillay, P. P., David, J. C., and Rajmarukum, 1935, *Ind. Jour. Med. Res.*, 765.

TRIBULUS TERRESTRIS Linn. (Zygophyllaceæ)**SMALL CALTROPS**

VERN.—Afg.—*Krunda*; Arab.—*Bastitaj*, *Busteyrumi*, *Khasak*; Beng.—*Gokhru*, *Gokhuru*; Bomb.—*Gokhru*, *Lahanagokru*, *Sarate*; C. P.—*Gokhru*; Eng.—*Calthrops*; Hind.—*Burrangokhur*, *Chhotagokhru*, *Hatechanghara*, *Hussuk*, *Gokhru*, *Gokhuru*, *Gokshri*; Mal.—*Neringil*, *Nerinnil*; Pers.—*Kharekhasak*, *Khussuck*; Punj.—*Bakhra*, *Bhukri*, *Gokhrudesi*, *Lotak*; Sans.—*Bahukantaka*, *Bhakshataka*, *Chanadruma*, *Gokantaka*, *Gokhura*, *Ikshugandha*, *Kanta*, *Kantaphala*, *Shvadanshra*, *Sudumstra*, *Trikantaka*, *Vanahringataka*; S. Africa.—*Devil's Thorn*; Tel.—*Chirupalleru*, *Palleru*; Urdu.—*Gokharu*.

T. terrestris is an annual or perennial plant growing throughout India and other warm countries such as Ceylon. The entire plant and specially the fruit and the root are used in the Hindu medicine. The fruits are regarded as cooling, diuretic, tonic and aphrodisiac, and are used in painful micturition, calculus affections, urinary disorders and impotence. In northern India it is used against suppression of urine, cough and heart diseases in the form of an infusion. The fruit forms one of the ten ingredients of the 'Dasamula kvatha', a compound decoction often mentioned in Sanskrit works.

The plant commonly grows near the Dardanelles and was known to the old Greek physicians. It is used in south Europe as an aperient and diuretic. The action of the drug on the mucous membrane of the urinary tract resembles that of buchu leaves and uvaursi flowers. It has been combined with hyoscyamus and opium in inflammatory conditions of the urinary passages.

CHEMICAL COMPOSITION.—The drug was analysed many years ago and was found to contain a body of alkaloidal nature. The fruit is said to contain a substance having an aromatic smell and it gives off a fragrant odour when it is burnt. The drug was reinvestigated by the author and his co-workers with a view to confirming the previous work and to see if it could be advantageously employed in therapeutics.

The following substances were found in the fruit of *T. terrestris*: (1) an alkaloid in traces (0.001 per cent.), (2) a fixed oil 3.5 per cent. consisting mainly of unsaturated acids, (3) an essential oil in very small quantities, (4) resins, and (5) fair amounts of nitrates.

An aqueous solution of the tartrate of the alkaloid was passed through preliminary pharmacological tests. It produced a slight rise of blood pressure and an appreciable increase in the kidney volume. The yield of the crude alkaloid did not amount to more than 0.001 per cent. and therefore sufficient quantities could not be obtained for further study. A method of its separation by precipitation with Meyer's reagent was tried, but this also did not produce any better result. The aqueous solution after removal of the alkaloid was found to contain sugars, etc., but no physiologically-active substance.

Ghatak (1933) investigated the fruit and found that it contains 5 per cent. of a semidrying oil, peroxidase, diastase, traces of glycoside, resin, protein and a large amount of inorganic matter. He also found that the peroxidase activity in the fresh fruit was highest between pH 5.3-5.5 and decreased with dilution.

Quin and Remington (1933) have observed that the plant causes photosensitization among small stock in South Africa and produces a disease Geildikkop which is characterised by the sudden onset of oedematous swelling of the exposed parts of the head and ears of sheep

and angora goats. This swelling of the skin is not present in the black faced sheep. When fresh green or dried plant was fed, no symptoms developed. Aqueous extract of the powdered plant or expressed green juice when fed caused death. In a search for the cause of the disease Geildikkop observations were made on *T. terrestris* by Henrice on different soils and under different physiological conditions. He found that stems were rich in starch, fructose was 5-10 times as high as glucose and there was often more sucrose than reducing sugars. Samples taken during an epidemic were extracted with ice water, or 0.9 per cent. sodium chloride after extraction with alcohol and ether. The plant was found to contain an unstable water soluble substance which causes effervescence and hemolysis. The substance is not soluble in ether or xylene and in fresh condition is not soluble in 96 per cent. alcohol. It gives positive tests for saponin with sulphuric acid. It is either a neutral saponin or a cardiac glycoside.

CLINICAL TRIALS. An alcoholic extract of the drug was prepared and tried in a series of cases. The drug undoubtedly has diuretic properties, but shows no advantage over many of the diuretics in the British Pharmacopoeia. The diuretic properties no doubt are due to the large quantities of the nitrates present as well as the essential oil which occurs in the seeds. The claims put forward regarding its efficacy in other conditions, as stated above, cannot be substantiated.

References:—

- (1) Chopra, R. N., and Ghosh, S., 1929, *Ind. Jour. Med. Res.*, 17, 377; (2) Ghatak, N., 1933, *Bull. Acad. Sci.*, 163; (3) Claude Remington, Quin, J. I., 1933, *S. African J.*, 472; (4) Henrice, M, *Ibid*, 1947, 225.

TYLOPHORA ASTHMATICA W. & A. (Asclepiadaceæ)

VERN.—Beng.—*Antomul*; Bomb.—*Anthamul*, *Kharakirasna*, *Pitmari*; Dec.—*Pitkari*; Hind.—*Antamul*, *Janglipikvan*; Mal.—*Vallippala*; Mar.—*Pitakari*; Tam.—*Kagittam*, *Kaludaiṭalai*, *Kodagam*, *Kondachani*, *Kuravaram*, *Kurinja*, *Peyppalai*, *Sarangam*, *Unmattadi*; Tel.—*Kakapala*, *Kukkapala*, *Mattukumittukoni*, *Nelatapire*, *Veripala*, *Vettipala*.

This plant is a perennial branching climber with long fleshy roots. It is found growing wild in the plains of India. It also occurs in forests and hilly places upto altitudes of 3,000 ft. above sea level throughout the southern and eastern parts of India. It grows abundantly in North and East Bengal, Assam, Kachar, Chittagong and in the Deccan peninsula. The whole plant is of a pale yellow brown colour and has no marked odour but has a sweetish and subsequent acrid taste. The medicinal properties of this plant have long been known to the natives of the parts where it grows, and have attracted the attention of the indigenous physicians. It is, however, not mentioned in any of the standard Sanskrit or Mohammedan works on *Materia Medica* but was a household remedy first brought to the notice of the Western medicine by Roxburgh. The roots of the plant have often been employed as a substitute for *ipecacuanha* and very favourable reports with regard to its efficacy were given by Roxburgh, Ainslie, O'Shaughnessy, Dobson and others. In large doses it acts as an emetic and in smaller doses, often repeated, as a cathartic. According to O'Shaughnessy the

emetic properties of the root were well established, but it was necessary to prescribe it in doses double those of ipecacuanha, for which it was considered to be an excellent substitute. On account of its well-marked emetic properties it was admitted as an official drug in the Bengal Pharmacopoeia of 1844. The dried leaves were made official as they were found to be more uniform and certain in their action than the roots. The leaves were described as one of the best indigenous substitutes for ipecacuanha and were recommended as useful in all cases indicating necessity of emesis and as a remedy for dysentery, catarrh, and other affections, in which ipecacuanha is generally employed. The dose as an emetic is from 25 or 30 grains of the powdered dried leaves and as a diaphoretic and expectorant from 3 to 5 grains thrice daily or oftener. Dose of the root as a remedy in dysentery is from 15 to 30 grains or more.

CHEMICAL COMPOSITION.—Hooper (1891) demonstrated the presence of a crystalline alkaloid, tylophorine, in the roots of the plant and described some of its characteristic colour reactions, but the quantity isolated by him was not sufficient for complete analysis. Ratnagiriswaran and Venkatachalam (1935) investigated the plant and isolated two crystalline alkaloids named tylophorine and tylophorinine. Tylophorine, $C_{24}H_{27}NO_4$, m.p. $284-85^{\circ}C.$, crystallises in glistening plates. Tylophorinine, $C_{23}H_{27}NO_4$, m.p. $232-33^{\circ}C.$, occurs in prismatic needles. The leaves, stem and root of the plant contain 0.2 to 0.3 per cent. of the total alkaloids and the alkaloidal content does not seem to be significantly affected by seasonal variations. Apart from alkaloids the plant also contains cetyl alcohol, a phytosterol m.p. $192-93^{\circ}C.$, a neutral substance of an alcoholic nature m.p. 89 to $90^{\circ}C.$, a wax, a resin, caoutchouc, chlorophyll, colouring matter, tannin, glucose, calcium salts and potassium chloride.

Simultaneously Chopra and Co-workers (1935-7) working with the whole plant isolated crystalline alkaloid in 0.42 to 0.62 per cent. yield. The alkaloid tylophorine isolated by them begins to melt with decomposition at $270^{\circ}C.$ and completely melted at $275^{\circ}C.$ Steam distillation of air dried root powder yields 0.18 per cent. of a colourless crystalline solid and a small amount of an oil. The solid was identified as methoxy salicylic aldehyde. The oil is viscous and deposits a small amount of waxy solid on standing.

PHARMACOLOGICAL ACTION.—Ratnagiriswaran and Venkatachalam (1935) observed that while working continuously during the extraction and isolation of the alkaloid one of them got dermatitis. The effect was particularly noticeable when working with solutions of the alkaloids in volatile solvents such as ether, chloroform and benzene. Aqueous acid solutions were not found to be so active. The eruption appeared on the skin a day after exposure the first symptoms being itching with subsequent redness. Skin of the face became red and the eyelids and surrounding tissues were markedly swollen. There was exudation of serous fluid from the cracks that had formed on the skin. The symptoms continued for about a week and then gradually subsided. Simultaneously, desquamation occurred in the form of small scales and large flakes of dried epidermis. The condition was relieved by moist compresses and the application of the usual soothing lotions. Richards and Lynn (1934) have reported the occurrence of dermatitis with symptoms similar to those described above due to contact with the leaves of *Ceanothus velutinus*, also an alkaloid containing plant though of a different family. The alkaloid tylophorine is toxic to *Paramecium caudatum* in concentration of

1 in 50,000 or more. The toxicity of the alkaloid which varies with different species of animals was worked out. The m.l.d. for frogs is 0.4 mg. per gm. of body weight but its toxicity for mice and guinea pigs is very low. The alkaloid has no irritant action locally on the conjunctiva or on the skin. When injected subcutaneously or intramuscularly it produces little or no local reactions.

From the experimental data obtained it would appear that the effect of the drug is especially marked on the musculature of the body, both the striped and unstriped varieties being stimulated. The action on the cardiac muscle is however different, the drug having distinct depressing effect on the heart. The blood pressure is lowered when a dose is administered, but is raised soon after and is maintained at a level higher than the normal for a fairly long time. The initial fall is due to the depressant effect of the drug on the cardiac muscle and the subsequent rise to the stimulant effect on the plain muscles of the blood vessels resulting in contraction and increased cardiac output. In cardiometer experiments there is distinct evidence of decrease of both the systolic and diastolic phases of the heart. In myocardiograph experiments the amplitude of both the auricular and ventricular contraction was decreased. This is probably due to the direct effect of the drug on the cardiac musculature and cannot be abolished by paralysing the vagal endings with atropine. The absence of any effect of the drug on the pupil is explained by the fact that the two sets of muscle fibres in the iris, the circular and the radial, are antagonistic to each other and the stimulant effect on the one counter-balances that on the other. As a result of this the pupil remains unaffected.

Clinical trials on any large scale have not been carried out to test its efficacy in dysentery. Further detailed studies of the action of the alkaloids are indicated.

References :—

- (1) Hooper, 1891, *Pharm. Jour.*, 617; (2) Richards, and Lynn, 1934, *J. Amer. Pharm. Assoc.*, 336; (3) Ratnagiriswaran and Venkatachalam, 1935, *Ind. Jour. Med. Res.*, 433; (4) Chopra, R. N., De, and Chakravarty, 1935, *Ind. Jour. Med. Res.*, 263; (5) Chopra, R. N., Ghosh, N. N., Bose, J. P., and Ghosh, S., 1937, *Arch. Pharm. Berl.*, 236; (6) Rao, P. S. 1948, *Proc. Ind. Acad. Sci.*, 173.

VANDA ROXBURGHII R. Br. (Orchidaceæ)

This is an epiphytic herb which grows throughout the hotter parts of India. It is common in Bengal, Chota Nagpur, Madhya Pradesh and in Cochin and Travancore. The plant is extensively used by both Ayurvedic and Unani practitioners. The roots of this plant are fragrant, bitter and considered to be useful in rheumatism and allied disorders for which they are prescribed in a variety of forms. They enter into the composition of several medicated oils used for external application in rheumatism and diseases of the nervous system. The drug is also said to be a remedy for secondary syphilis. In Chota Nagpur the leaves pounded and made into a paste, are applied to the body in febrile conditions and in inflammatory conditions of the ear such as otitis media the juice is dropped into the ear. It has been employed as a remedy against scorpion sting but Caius and Mahaskar found it useless as an antidote to either snake or scorpion venoms.

CHEMICAL COMPOSITION.—Dymock in *Pharmacographia Indica* mentions the presence of an alkaloid in the plant. Gupta and co-workers (1946) investigated the plant and showed the presence of a substance of glycosidal nature but could not crystallise it. Besides this, the plant also contains tannins, saponins, sterols, fatty oils, resins and colouring matter.

PHARMACOLOGICAL ACTION.—The active constituent which is glycosidic in nature, appears to be of very low toxicity in frogs, rats and mice. In experimental animals the drug stimulates all organs having autonomic cholinergic nerve-supply. Atropine antagonizes this stimulation to a large extent, but does not completely abolish it. It seems, therefore, that apart from stimulating the cholinergic nerve endings, the drug also exerts some direct action on the involuntary musculature of these organs. The drug produces a short initial rise of blood pressure, followed by a subsequent fall, which is due to stimulation of the cholinergic nerve-endings. The heart is slowed and cardiac output diminished. The peripleral arterioles are also dilated and these two factors together are probably responsible for the fall in blood pressure. No clinical trials have so far been carried out.

References:—

(1) Dymock, Warden, and Hooper, 1943, *Pharm. Ind.*, 294; (2) Gupta, J. C., Roy, P. K., Sen Gupta, 1946, *Ind. Jour. Med. Res.*, 253.

VERNONIA ANTHELMINTICA Willd. (Compositæ)

VERN.—Sans.—*Vakuchi*, *Somaraja*; Hind.—*Bakchi*, *Somraj*; Beng.—*Somraj*; Bomb.—*Kali-jiri*; Guj.—*Kadvo jiri*; Tam.—*Kattu-shiragam*; Tel.—*Adavi-jilakara*.

It is a stout annual with a cylindrical stem, oval or lanceolate leaves and pale violet flowers. It is commonly found in waste lands near villages throughout India. The seeds are highly reputed in Hindu medicine as a remedy for leucoderma and other skin diseases. They are mentioned also as an anthelmintic but are little used as such except in combination with other drugs. Chakradatta describes several elaborate combinations for its external and internal use. This drug attracted the attention of the European physicians in India, and an infusion of the powdered seeds was considered by many to be a good anthelmintic for roundworms.

CHEMICAL COMPOSITION.—The seeds are said to contain resins, an alkaloid known as vernonine, an oil and ash amounting to about 7 per cent. of the dry material. Their chemical composition was reinvestigated in the School of Tropical Medicine. The powdered dry seeds, when extracted successively with different solvents, gave the following extracts: petroleum ether 18.4 per cent., chloroform 1.2 per cent. and absolute alcohol 13.8 per cent. The petroleum ether extract consisted mainly of a fixed oil (about 18 per cent. of the seeds) and a very small amount of an essential oil (about 0.02 per cent.). The chloroform extract contained a bitter substance. The alcoholic extract consisted mainly of resins. There was no alkaloid present.

The bitter principle, which was presumably the active principle of the drug, amounted to over 1 per cent. of the weight of the seeds. It was isolated on a larger scale by extracting the powdered seeds with rectified spirit until all the bitter substance was removed. The alcohol was recovered and the residue repeatedly extracted with chloroform and filtered. The chloroform extract was concentrated and the bitter substance precipitated with petroleum ether. This process was repeated several times until the bitter substance was obtained as a yellow amorphous powder. It contained no nitrogen or sulphur and behaved as a resin acid.

Majumder (1943) extracted the seeds with petroleum ether and obtained 17.33 per cent. of oil which had unsaponifiable matter 1.68 per cent. and this fraction contained brassicasterol, stigmasterol and a sterol. Other fractions contained stearic, palmitic, myristic, oleic, mono-hydroxy-oleic acids and two non crystalline bitter principles or resins. Vidyarathi (1945) found that the oil contains resin 2 per cent., myristic 7.4 per cent., palmitic 7 per cent., stearic 5.9 per cent., oleic 5.7 per cent., linoleic 9.6 per cent. and vernolic acid, m.p. 21-2°C. 52.4 per cent.

THERAPEUTIC USES.—The powdered resin, in doses of 5 to 10 grains, was tried in a number of cases of helminthic infections at the Carmichael Hospital for Tropical Diseases. The stools were carefully examined before and after the drug was given. The resin appears to have very little effect on the ascaris. It is, however, distinctly effective in threadworm infections. In several children in whom the resin powder was administered, threadworms were expelled in the stools in large numbers and the symptoms which are often very troublesome, *e.g.* nocturnal enuresis, grinding of the teeth at night, etc., were relieved.

References :—

(1) Majumdar, D. N., 1943, *Ind. Jour. Pharm.*, 61; (2) Vidyarathi, N. L., 1945, *Patna Univ. J.*, 51.

VITEX PEDUNCULARIS Wall. (Verbenaceæ)

VERN.—Assam.—Osai; Beng.—Boruna, Goda; Hind.—Charaigorwa, Chhagriaruba, Minjurgorwa, Nagbail, Nagpheni.

V. peduncularis is a middle-sized or large deciduous tree which grows in Bihar, Eastern Bengal and the Madhya Bharat. The plant does not seem to be very well-known as the only reference regarding its medicinal properties by the old writers is its use for external application for pains in the chest. Vaughan (1921) found that the aboriginal tribes of certain parts of Bihar were well acquainted with this plant and used it in the treatment of malarial fevers and also of blackwater fever which sometimes occurs among them. They prepare an infusion of the leaves or of the root bark or young stem and take it internally several times a day with much benefit. Preference is given to dark-coloured root plant over the pale-coloured variety.

Gupta (1950) obtained the following results while extracting the leaves with different solvents: petroleum ether (40-60°C.) 2.21 per cent., benzene 2.49 per cent., sulphuric ether 0.38 per cent., chloroform 0.59 per cent., ethyl acetate 1.61 per cent., absolute alcohol 4.63 per cent., water 13.10 per cent., of extracted matter. Of the above extractives anti-haemolytic action was noticed in aqueous as well as in alcoholic extracts, while chloroform extract showed slight potency. He isolated a glycoside with certain degree of purity and this has been found to possess a very marked antihaemolytic action.

CLINICAL TRIALS.—Vaughan tried this drug in a series of cases in both these diseases and reported that it gave very satisfactory results. He originally used the method of making an infusion employed by these tribes. This consisted in taking two ounces of fresh leaf

or of leaves dried in the shade and dropping them into 40 oz., of water, boiling for 5 to 10 minutes and then leaving them to infuse for another hour. The resulting infusion was about the colour of strong cold tea in appearance and in taste, and was given sweetened with a little sugar in doses of 8 to 10 oz., in 24 hours. Concentrated infusions prepared on the lines of infusio gentianae compositum of the British Pharmacopoeia were also tried by him, but the therapeutic effects were not so good. He adopted the method of using 1, 2 and 4 oz. of leaves in 40 oz. of water to suit different cases and the results obtained by this treatment were said to be very striking.

The drug was tried in a number of patients suffering from malarial fever at the Carmichael Hospital for Tropical Diseases. The results obtained were, however, not satisfactory and did not give any indication of usefulness of the preparation. Fresh specimens properly collected were then obtained and infusion made from these was tried in another series of cases. All the cases which were put on the infusion were first examined for malarial parasites and only such cases as were positive were given the infusion. Daily blood films were taken and a careful search was made for parasites. No other drugs were administered whilst the infusion was being tried with the exception of ordinary purgatives. None of the cases derived the slightest benefit from the use of the drug. The parasites in the blood remained quite unaffected and so did the clinical symptoms. In one or two cases the fever abated somewhat, as often happens without any treatment, but in these cases parasites were still found in the blood films. In two of the patients the infusions had to be replaced by quinine mixture after two days' trial, as the patient started to show signs of irritation of the central nervous system. A few doses of the latter drug immediately got the symptoms under control.

Neither the asexual nor the sexual forms of *P. vivax*, *P. malariae* or *P. falciparum*, were affected in the slightest degree. In all these cases quinine or cinchona febrifuge in the usual doses produced a rapid disappearance of parasites from the blood and the fever and other symptoms rapidly subsided.

SUMMARY.—Chemical analysis of the dried leaves of *V. peduncularis* shows the presence of minute traces of an alkaloid. In our series of cases of malarial fever, however, caused by *P. vivax*, *P. malariae* and *P. falciparum*, the freshly-prepared infusion of dried leaves had no effect whatever on the parasites in the blood, on the temperature chart or on the other clinical symptoms. The drug appears to be absolutely useless in the treatment of malaria.

References:—

(1) Chopra, R. N., and Knowles, R., 1924, *Ind. Med. Gaz.*, 59, 133; (2) Gupta, J. C., 1950, *Annual Report Ind. Coun. Med. Res.*, 323.

WITHANIA SOMNIFERA Dunal (Solanaceæ)

VERN.—Arab.—*Kaknajehindi*; Beng.—*Ashvaganda*, *Asvagandha*; Bomb.—*Asgund*, *Asvagandha*; Hind.—*Asgand*, *Punir*; Mal.—*Amukkiram*, *Pevetti*; Mar.—*Askandha*, *Kanchuki*, *Tilli*; Pers.—*Kaknajehindi*, *Mehernanbarari*; Punj.—*Ak*, *Aksan*, *Asgand*, *Asgand nagori*, *Isgand*; Sans.—*Ashvagandha*, *Ashvakandika*, *Ashvaroha*, *Balada*, *Balaja*, *Gandhapatri*, *Hayapriya*, *Kala*, *Kambuka*, *Kamurpini*, *Kushthagandha*, *Kushthagandhini*, *Palashaparni*, *Priyakari*, *Pushtida*, *Pushtipavira*, *Turgi*, *Vajigandha*, *Vajini*, *Varagatrakari*, *Varahakarni*, *Varahpatri*,

Vataghani; Tam.—*Amukkira*, *Asubam*, *Asuvagandi*; Tel.—*Asvagandhi*, *Dommadolu*, *Penneru*, *Pillivendramu*, *Vajigandha*; Urdu.—*Asgandanagaori*.

This is an erect shrub found throughout the drier parts of India, Baluchistan and Ceylon. The shrub as a whole, is employed for several medicinal purposes. Both in the Ayurvedic and Yunani Medicine the leaves are applied locally to tumours and to tuberculous glands. The tuber has a bitter, sharp, acrid taste and is useful in the treatment of inflammatory conditions, psoriasis, bronchitis, ulcers and scabies when applied locally. Internally it is given in marasmus in children. In Rajputana the roots are regarded as beneficial in rheumatism and dyspepsia. In the Punjab it is used for lumbar pains and in Sind it is used to produce abortion. In Wad and Kalat, a fomentation of the leaves is used as a cure for ophthalmia. An enema of the decorticated root is given by the Zulus to feverish infants. They regarded the plant as a specific for gangrenous rectitis and in the treatment of syphilis. The ground root and bruised leaves are employed as a local application to carbuncles, ulcers and painful swellings. The fruit is considered a diuretic.

CHEMICAL COMPOSITION.—Trebut (1886) investigated the plant and found that it had hypnotic and sedative properties due to the presence of an alkaloid somniferine. This work has not been confirmed, nor has the presence of any other constituents in the plant been recorded. Power and Salway (1911) on examination of the various parts of the plant found that the roots contain traces of an essential oil. The water soluble portion of the root extract contains, besides the indefinite amorphous substances, a quantity of sugar. The water soluble extract consisted chiefly of a black resin which contained hentriacontane, $C_{31}H_{64}$; a phytosterol, $C_{27}H_{46}O$ (m.p. $135-36^{\circ}$), a mixture of fatty acids consisting of palmitic, stearic, cerotic, oleic and linolic acids, ipuranol, $C_{23}H_{38}O_2(OH)_2$, a new monohydric alcohol, withaniol, $C_{23}H_{38}O_4CH$, which decomposes at $305^{\circ}C$. and an amorphous alkaloidal principle which on treatment with alkalis yielded a crystalline base, $C_{12}H_{16}N_2$ (m.p. 116°). The water soluble extract of leaves and stems also contains the same constituents in addition to considerable quantities of potassium nitrate. The water insoluble extract was also found to contain a number of substances which had been isolated from the roots of the plants. In addition to these, however, it yielded a new monohydric alcohol, semnirol, $C_{32}H_{48}O_6.OH$, decomposing at $205^{\circ}C$. a new dihydric alcohol somnitol, $C_{33}H_{44}O_5(OH)_2$ decomposing at about $250^{\circ}C$. and an acidic, hydrolytic product withanic acid, $C_{28}H_{45}O_5CO_2H$ (m.p. $226^{\circ}C$.), the methyl ester of which decomposed at $255^{\circ}C$. Majumdar and Guha (1933) investigated the Bengal variety of the plant and found that it contained the same constituents as the South African variety, i.e., potassium nitrate, tannin, colouring matter, glucose, phytosterol hentriacontane, stearic, palmitic, oleic, linoleic, withanic acid, ipuranol, somnirol and an alkaloid, $C_{12}H_{16}N_2$. The presence of three other alkaloids was also noted.

PHARMACOLOGICAL ACTION.—*W. somnifera*, unlike some other solanaceous plants had been found to contain no mydriatic alkaloid. The point whether the plant has any sedative or hyponotic properties commonly attributed to it has received attention. Work in the Wellcome Physiological Research Laboratories London showed that alcoholic extracts representing about 7 gm. of the root and 3 gm. of the leaves and stems respectively when administered to a dog had no perceptible effect. The hypodermic injection of the alkaloidal principle obtained from

the root likewise produced in a dog no symptoms of narcosis or any other definite results.

Pitini (1924) administered 3 gm. per kg. of a 16 per cent. aqueous extract to a dog and observed a slight soporific action followed by complete return to normal. The medicinal properties attributed to this plant are probably due to mild sedative effect of its active principles.

References:—

- (1) Trebut, 1886, *The Lancet*, 467; (2) Power, and Salway, 1911, *J. Chem. Soc.*, 490; (3) Majumdar, D. N., Guha, P. C., 1933, *J. Ind. Inst. Sci.*, 29; (4) Pitini, A., 1924, *Arch. Farm. Sper.*, 151.

XANTHIUM STRUMARIUM Linn. (Compositæ)

VERN.—Assam.—*Agara*; Beng.—*Banokra*; Bomb.—*Shankeshvara*; Eng.—*Bur-weed*, *Clother*, *Cocklebur*; Hind.—*Banokra*, *Chhotagokhru*, *Shankhahuli*; Kash.—*Lanetsuru*, *Tsur*; Punj.—*Chirru*, *Gudal*, *Jojre*, *Kuri*, *Sungtu*, *Wangantsuru*; Sans.—*Arishta*, *Bhulagna*, *Chanda*, *Itara*, *Kambumalini*, *Kambupuspha*, *Kiriti*, *Malavinashini*, *Mangalyakusuma*, *Medhya*, *Raktapushpi*, *Sarpakshi*, *Shankhagalini*, *Shankhakusuma*, *Shankhapuspi*, *Shankhavha*, *Sukshmapatra*, *Supushpi*, *Vanamalini*; Tam.—*Marlumutta*; Tel.—*Marulamatangi*, *Marulutige*, *Parsvappu*, *Talnoppi*.

It is a coarse annual herb which grows abundantly throughout the hotter parts of India usually near the outskirts of villages and ascends in the western Himalayas upto an altitude of 7,000 ft. above the sea level. The fruit is used as a household medicine in the Punjab and Sind. It is considered to be cooling by practitioners of indigenous medicine and is believed to be effective in the treatment of small pox. The root is believed to be a bitter tonic and said to be useful in cancer and strumous diseases. In south India the prickly involucre is applied to the ear tied in bunch to the earring to cure hemicrania. The whole plant is supposed to possess powerful diaphoretic and sedative properties. It is generally administered in form of a decoction and is said to be effective in long standing cases of malarious fevers. The herb is prescribed in the treatment of snake-bite and scorpion-sting but Caius and Mhaskar have found it entirely useless in both these conditions.

CHEMICAL COMPOSITION.—Zander (1881) investigated the plant and found that it contains fat 38.6 per cent., albuminoids 36.6 per cent., a glycoside xanthostrumanin 1.3 per cent. and organic acids besides sugar, resins, etc. Xanthostrumanin is an amorphous yellow glycoside which is soluble in water, alcohol, ether, benzene, chloroform and yields precipitates with group reagents for alkaloids, with ferric chloride, lead acetate and with salts of other metals. It is not precipitated by tannin or gelatine. Cheatham (1884) investigated the fruit and obtained only 14.5 per cent. of a fixed oil and a principle which was precipitated by tannin. Maksimov (1940) examined the seeds and obtained 41.7 per cent. of a fixed oil which has most of the physical and chemical properties of sunflower seed oil. It contains saturated acids 8.2 per cent., oleic acid 27.1 per cent. and linoleic acid 63.36 per cent. The

residue after the extraction of the oil contains proteins 47.80 per cent., crude protein 54.35, cellulose 5.42, fat 3.70, extractive substances 6.12 and ash 8.76 per cent.

PHARMACOLOGICAL ACTION.—The effect of the glycoside on blood pressure and respiration was determined by animal experiments. Administration of as much as 30 mg. to 40 mg. per kg. did not produce any marked effects. A medium size rabbit survived without any remarkable effect on the respiration and blood-pressure even after the administration of a total of 120 mg. of the glycoside. It would, therefore, appear to be physiologically a relatively inactive substance.

Clinical trials have not yet been carried out, but from the active principles isolated, it is not likely to have any marked therapeutic action.

References :—

(1) Zander, 1888, *Pharm. Z. Russland*, 661; (2) Cheatham, *Apoth. Ztg.*, 1891, 133; (3) Chopra, I.C., Kohli, J. D., Handa, K. L., 1945, *Ind. Jour. Med. Res.*, 135; (4) Maksimov, 1940, *Compt. rend. acad. Soc., U.S.S.R.*, 393.

SECTION II

DRUGS OF MINERAL AND ANIMAL ORIGIN

Most of the recent investigations on the Indian indigenous drugs have been confined to drugs of vegetable origin. The reason for this is not far to seek. The vegetable drugs from the very early times have formed a predominant portion of the materia medica of both the Hindu and the Mohammedan medicine in this country. The drugs of animal origin, although very largely used in the ancient Chinese materia medica, were little used by the Hindu physicians and are few in number. As regards the drugs of mineral origin, their use is also comparatively limited. It would appear that the ancient Hindus were not quick in learning the art of adopting the metals and metallic compounds for medicinal purposes. It is well-known that one of the earliest works on Hindu medicine by Charaka does not deal at all with any mineral drug. Susruta, written at a latter period, only mentions the use of a few natural salts such as sodium chloride, impure carbonates of sodium and potassium, borax and some salts of iron, silver, copper, tin and lead as well as some precious stones. Only writers of considerably later periods gave descriptions of calcination and purification of compounds and other process of converting such metals as gold, silver, iron, copper, mercury and arsenic into suitable forms for use as medicaments. The Mohammedan physicians, though they used the drugs of animal origin to a larger extent than the Hindus, also made use of the inorganic preparations to a limited extent. Many of their methods of preparation of these medicaments resemble those used by the Hindus. Before using the metals or metallic compounds, they are always subjected to processes called 'shodhana' or purification. The idea of this is to get rid of the impurities and their deleterious qualities. If this 'shodhana' is not performed, their use is said to be injurious to the individual. 'Shodhana' is usually carried out by heating thin sheets of metal repeatedly and plunging them into various vegetable juices, decoctions, etc. The other process described is 'marana' or destroying the metals so that they lose their identity and become converted into fine powders which are chemically of the nature of oxides or sulphides. Here the idea appears to be to convert the metals into such a form as can be acted upon by the intestinal juices and so rendered absorbable. These preparations are absorbed very slowly and in this way minute concentrations having a stimulant action on the tissues are obtained and higher toxic concentrations are avoided. Many of the other inorganic compounds in use are practically the same as those used in the Western medicine and their action is well-known. Very little, however, is known about the action of the second group of destroyed metals and it is to the absorption and effects of these compounds that attention of the workers may be directed. In this section we have discussed a very few drugs; the attention of the reader is directed to the lists in Part IV.

DRUGS OF MINERAL ORIGIN

ABHRA BHASMA (Ash of Mica)

Abhra, Abh or mica is a mineral which occurs in sheets of moderate thickness forming a compact mass and capable of being cleaved into flexible plates of extreme thinness. It is widely distributed in India, the principal source of supply being the districts of Hazaribagh, Kodarma, Jamtara, Gaya, Monghyr, some parts of Rajputana and the Punjab and some granite veins in the hills of Mysore and the Western Ghats. The chief constituents of mica are potassium, aluminium, silica, magnesium and iron with traces of lime. Four principal varieties are mentioned by Hindu medical writers, namely, white, yellow, red and black; only the last-mentioned variety, which is the mineral Biotite, $K_2HAl_3(SiO_4)_3(MgFe)_6(SiO_4)_3$, is used for medicinal purposes. The black variety, again, is classified under four distinct heads according to certain physical properties. When thrown into fire, 'Dardur' (frog) leaps like a frog in the fire (due to explosions); 'Nag' (snake) produces a hissing noise like that of serpents; 'Pinak' (the bow or trident) separates into layers on the fire; and the last but most important variety, known as 'Vajra abhra' (impenetrable like thunder) is so called because it remains quiet even on strong heating. When administered, the black 'Dardur' is believed to cause death, the 'Nag' leprosy, the 'Pinak' fistula, but the last variety, when properly purified, is not injurious to the human system. Consequently, it is only the Vajra abhra which is used in Ayurvedic medicine.

PURIFICATION.—The black Vajra variety of 'Abhra' is burnt in fire made of cowdung cake and, while red-hot, is dipped into pure cow's milk. Its layers are then separated and soaked in the juice of *Amaranthus polygamus*, a kind of vegetable commonly known as Kanta Notay in Bengal, together with some acid, preferably Kanji (vinegar), for eight days. It is then known as 'Sodhita' or purified abhra. This is mixed with one-fourth of its weight of Shali Dhanya (a variety of paddy) tied in a blanket and soaked with water for three days. The abhra contained in the blanket is then rubbed by hand, when fine sandy particles pass through the interstices of the fabric and are collected for use. This is known as 'Dhanyabhra.' It is further treated with cow's urine and rubbed in a mortar and the pasty mass is heated by a process known as 'Gajaputa' which is done by putting the paste in a closed crucible consisting of two concave earthen basins placed one above the other and the joints closed by a mixture of cowdung with earth. It is then subjected to a very strong heat. The 'abhra' loses all its shining particles and acquires a brick-red colour. This is known as 'Abhra Bhasma'. Sometimes the ignition is repeated several hundred times and efficacy of the medicine is said to be enhanced by the number of such ignition. When ignited one thousand times it is known as 'Sahasraputita Abhra'. It is of buff colour and has slightly saline and earthy taste. 'Abhra Bhasma' undergoes another process of purification known as 'Amritkaran' or nectarification. Two seers of the decoction of Trifala or three myrobalans consisting of *Phyllanthus emblica*, *Terminalia chebula*, and *Terminalia belerica*, together with one seer of clarified

butter, and one-fourth seer of Abhra Bhasma are mixed together and heated in an iron pan at a low heat till the mixture dries up. It is then powdered and used as such. Besides these there are other processes of purification of abhra.

CHEMICAL COMPOSITION.—At the suggestion of Kaviraj Gananath Sen, a sample of 'Abhra Bhasma' supplied to us by the Kalpataru Ayurvedic Works of Calcutta was analysed. It was a buff coloured amorphous powder with a very slight saline taste. On analysis one hundred parts of the sample was found to contain the following ingredients:

	Percentage
Silica (SiO_2)	36.01
Ferric oxide (Fe_2O_3)	12.78
Alumina (Al_2O_3)	27.57
Lime (CaO)	5.03
Magnesia (MgO)	1.92
Potash (K_2O)	13.17
Soda (Na_2O)	3.06
Chlorides	0.09
Sulphates	nil
Phosphates	vern faint trace
Nitrates	nil
Moisture	0.37
Total	100.00

The total water-soluble portion found to be 6.666 parts were soluble in boiling water. The soluble matter consisted of:

	Parts
Silica (SiO_2)	2.094
Iron and Alumina (Fe_2O_3 and Al_2O_3)	0.055
Lime (CaO)	0.192
Magnesia (MgO)	1.118
Potash (K_2O)	2.924
Soda (Na_2O)	0.196
Chlorides (NaCl)	0.087
Total	6.666 parts.

Lastly, 2.5 gm. of the sample were digested in 250 c.c. of 0.26 per cent. hydrochloric acid solution, the approximate strength of acid found in gastric juice, at a temperature of about 37°C . for twenty four hours. The total solubility was 31.288 parts which on analysis gave the following results:

	Parts
Silica (SiO_2)	6.645
Alumina (Al_2O_3)	8.300
Iron oxide (Fe_2O_3)	2.116
Magnesia (MgO)	1.907
Lime (CaO)	0.884
Potash (K_2O)	8.377
Soda (Na_2O)	3.059
Total	31.288 parts.

From the results of the last two analyses it appears that the various preliminary treatments, known as 'purification' have altered some of the properties of the mineral. At the high temperature to which it is subjected, it is hardly possible that any of the organic matter

could have been left behind and the analyses bear out this assumption. The treatments have possibly converted a portion of the mineral into oxides or carbonates or into some other form which can be dissolved out more easily. It was originally almost insoluble in water or in dilute hydrochloric acid, but, after the treatment, a high percentage goes into solution, especially in acid of approximately the strength found in gastric juice.

PHARMACOLOGICAL ACTION AND THERAPEUTIC USES.—Abhra Bhasma is considered to be a tonic and, in combination with preparations of iron, it is used in chronic diseases such as diarrhoea, dysentery, fever, diabetes, anaemia, jaundice, enlargement of spleen, it is prescribed in doses of 6 to 12 grains. The results of analyses given above show that a high percentage of the metallic constituents exist in a soluble form and the pharmacological actions and therapeutic properties of some of these are known. Whether these produce any remarkable effects in the dosage in which they are prescribed by the indigenous practitioners is problematical, for they are never given alone but always in combination with various preparations of organic and inorganic origin. We have tried this preparation by itself in a number of patients suffering from diabetes without producing any apparent effect on the urine or blood sugar. Small doses of metallic substances absorbed may produce stimulation of the tissues generally and haematinic effects, but these were not very remarkable in our series of cases and it was not considered worth while to proceed with further trials.

References:—

(1) Ainslie, W., 1826, *Materia Medica of the Hindoos*, 1, 421; (2) Dutt, U. C., 1922, *Materia Medica of the Hindoos*, 68; (3) Roscoe, H. E., and Schorlemmer, C., *Treatise on Chemistry*, 2, 711; (4) Sen Gupta, N. N., 1911, *Ayurvedic System of Medicine*, 2, 22; 3, 10; (5) Watt, G., 1891, *Dictionary of the Economic Products of India*, 5, 240; (6) Chopra, R. N., Ghosh, S., and Dutt, A. T., 1934, *Ind. Jour. Med. Res.*, 285.

BANGA BHASMA (Calcined Tin)

Tin occurs in nature in combination with oxygen in the mineral Cassiterite or Tinstone, which is more or less a pure form of tin dioxide, SnO_2 . It is found also as tin pyrites and sometimes as a silicate, but the principal source of tin is the dioxide. Tin has been known in India from ancient times. Its vernacular name is Banga in Sanskrit and Rang in Hindi and Bengali. It is said to occur in Peninsular India and in the district of Hazaribagh in Bihar. The chief source of tin in and near India is Burma, Tenasserim and Malaya Archipelago. Like other metals which have been used in old Hindu Medicine, tin has been used in the form of crude oxide which is prepared by a complicated process of so-called 'purification', but which really reduces it to a state of impure oxide. The following process is generally adopted for this purpose: Metallic tin is heated in an iron pan until it is melted and the molten mass is poured into the milky juice of Akra (*Calotropis gigantea*). It is then re-melted with one-fourth of its weight of Yabaksara (impure carbonate of potash) and powdered husk of tamarind is added to it. The whole mass is stirred well with an iron-rod till it is reduced to a very fine powder. The powder is then washed with cold water and dried over a gentle fire. Another method of preparation is to heat the metal on fire in an iron pot; when molten, powdered turmeric, Jirak (*Cuminum cyminum*), Trifala, i.e., the

three fruits of Haritaki (*Terminalia chebula*), Bahera (*Terminalia belerica*) and Amlaki (*Phyllanthus emblica*) powder of Aswath (*Ficus religiosa*) and tamarind barks are put in one after the other and stirred. The next powder is only put in when the one previously added is thoroughly burnt. The product thus obtained is a greyish white fine powder and is known as Banga Bhasma or ash of tin. According to well-known Ayurvedic physicians, Banga Bhasma is used in the following diseases with different vehicles (Anupana) usually in combination with other mineral preparations like the Bhasmas (ashes) of gold, silver, zinc, iron, etc. Sometimes it is used alone. Its main indication is in the treatment of inflammatory and suppurative conditions of stomach, urethra and other mucus surfaces. It is believed to be a general tonic and alterative and is often combined with Silajatu and Abhra Bhasma for this purpose. Its chief uses are in diabetes, spermatorrhoea, gonorrhoea, anaemia, asthma, gastric ulcer and in various skin diseases. The dose is from one to four grains.

CHEMICAL COMPOSITION—A sample of Banga Bhasma supplied by the Kalpataru Ayurvedic Works of Calcutta was analysed. The sample was a dull-grey amorphous powder with a slightly metallic and saline taste. It was soluble in hot water to the extent of 1.12 per cent. The chemical composition found as the result of qualitative and quantitative analyses is given below:

	Per Cent.
Oxide of Tin(SnO_2)	82.94
Silica(SiO_2)	6.38
Iron and Alumina(Fe_2O_3 , Al_2O_3)	2.96
Lime(CaO)	1.92
Magnesia(MgO)	0.69
Potash(K_2O)	2.96
Soda(Na_2O)	0.45
Chlorides	0.11
Moisture	0.89
Other constituents	0.70
Total	100.00

The solubility of Banga Bhasma in dilute hydrochloric acid of a strength approximating that found in gastric juice was also studied. For this 2.0 gm. of the Bhasma were digested in 200 c.c. of 0.3 per cent. of hydrochloric acid at a temperature of 37°C . for 24 hours. The total solubility was 7.726 per cent. The soluble portion when analysed quantitatively was found to have the following composition:

	Parts
Oxide of tin(SnO_2)	1.060
Silica(SiO_2)	0.342
Lime(CaO)	2.072
Iron oxide(Fe_2O_3)	0.243
Aluminium oxide(Al_2O_3)	0.137
Magnesia(MgO)	0.371
Potash(K_2O)	2.967
Soda(Na_2O)	0.424
Chlorides	0.110
Total	7.726

TIN IN PHARMACOLOGY AND THERAPEUTICS.—Experiments have shown that when soluble salts of tin are given to animals a small quantity is absorbed and accumulates in the tissues and tin appears in the urine. When soluble salts are given by subcutaneous injections, elimination is slow and occurs mainly by the alimentary tract, but somewhat by the urine also. Diuresis results after administration of small doses, but large doses have a deleterious effect on the kidneys and produce pathological changes in this organ. Large quantities of tin are retained in the body after administration, of which 20 to 25 per cent. is in the skin and 5 per cent. in the liver. It will be seen from the data given above that appreciable quantities of oxide of tin occurring in the Bhasma will be dissolved in the physiological acid of the gastric juice and will be absorbed into the system. Like other heavy metals small quantities of tin have a stimulant action on the central system and also on haemopoietic system and in this way may have a general stimulant action and may be beneficial in such conditions as diabetes. The diuretic action is beneficial in chronic gonorrhoea and possibly traces of the metal in the urine may have some inhibitory effect on the organism responsible for this disease.

The action of tin on the heart is like that of arsenic and is probably through the vagus. It is possible that in its beneficial effects in asthma it may act by depressing the vagi in the same way as arsenical compounds like *soamin* do. The use of tin in the treatment of skin diseases by the Ayurvedic physicians is rather interesting in view of the fact that there is a tendency for the metal to accumulate in the skin. It has been observed that workers in tin mines do not suffer from furuncles and based on this observation stannoxyl was introduced which has been successfully tried in patients suffering from furunculosis. It may be worth while extending these trials in the treatment of such chronic and persisting diseases as eczemas, psoriasis, etc. The nervous system is especially sensitive to this metal and large doses may produce peripheral neuritis, excitability and sclerosis of the brain or the spinal cord. The therapeutic effects of tin compounds, however, are not so powerful as some of the compounds of other metals in use in Western medicine. Further investigations were, therefore, not considered necessary.

References:—

- (1) Ainslie, W., 1826, *Materia Medica*, 1; (2) Dutt, U. C., 1922, *Materia Medica of Hindoos*; (3) Khory, R. N., and Khatrak, N. N., 1903, *Materia Medica of India and their Therapeutics*; (4) Sen Gupta, N. N., 1911, *Ayurvedic System of Medicine*; (5) Chopra, R. N., Ghosh, S. and Dutt, A. T., 1936, *Ind. Jour. Med. Res.*, 257.

LAUHA BHASMA (Calcined Iron)

INTRODUCTION.—Iron has been one of the most important agents in the Hindu medicine from time immemorial. Preparations of iron have been extensively employed in different pathological conditions in combination with compounds containing vegetable drugs, spices, aromatic substances, as also the compounds of other metals, in the treatment of different ailments. In fact iron was regarded as one of the most useful therapeutic agents in the ancient Hindu medicine. The chemistry and metallurgy of iron were highly developed in India from very ancient

times. In the 'Rasaratnasamuchchaya' a treatise on Hindu chemistry, three special types of metallic iron, viz., Mundam (wrought iron), Tikshanam (probably cast iron), and Kantam, have been differentiated. In a like manner in the 'Materia Medica of the Hindoos' by U. C. Dutt three different kinds of iron (or its preparations) have been enumerated from the therapeutic point of view. The first of these is the Kanta Lauha (cast iron) which was at that time used in making iron vessels or pans wherein milk or other liquids were warmed or boiled. In medicinal preparations where iron would be required as a mere catalytic agent for some transformation to take place or where traces of iron in actual chemical combination would be required, the preparations were usually made in such iron vessels. The second form of iron useful in therapeutics was Mandura which in all probability constituted the rust of iron. Mandura consisted of scales of various sizes which come off when hot iron was beaten on an anvil. These scales were then allowed to remain in contact with earth till became brittle and appeared rusty. In this state they were considered very suitable for medicinal purposes. The properties of Mandura were said to be very similar to those of Kanta Lauha. The Lauha Sara which formed the third variety probably means salt of iron. These were prepared by exposing to the action of various vegetable organic acids. The process of chemical action of the acids was carried out by besmearing iron plates with vegetable acids derived from fruits such as tamarind, lemon, etc., when granules made their appearance on the plate. These granules which were obviously particles of salts formed by the union of the iron with the acids used, were supposed to be very useful in certain diseases such as dyspepsia, nervous diseases, chronic blood complaints and diarrhoea. Besides the few varieties of iron preparations mentioned above there are many others, some simple, other complicated, which are used in the Hindu medicine. The usual diseases for which such preparations were used are generally those of the blood, bowels and nerves. Iron preparations are never administered alone in such conditions but always along with some correctives which are considered essential to obtain full therapeutic effects and to exclude the toxic effects. These correctives are not only different preparations of iron, but sometimes they differ even for the same preparation if used for different purposes or in different diseases.

LAUHA BHASMA.—Although iron preparations were extensively used in medicine, metallic iron seldom found its use in the Ayurvedic system as it was believed to be highly toxic producing 'sule' (colic or pain), leprosy, heart disease, stone in the bladder, impotency and possibly even death. It was, therefore, always 'purified' before use for medicinal purposes. For this purpose thin sheets of iron were heated and then macerated in each of the following substances: (1) oil, (2) whey, (3) kanji or dilute vinegar, (4) cow's urine and aqueous extract of Kulatha Kalai (*Dolichos uniflorus*) seven times in succession. The iron thus treated is again heated on fire and macerated successively in milk, kanji (dilute vinegar), cow's urine and in the extract of the three myrobalans, viz., *Terminalia chebula*, *Phyllanthus emblica*, and *Terminalia belerica*. The plates of iron were then reduced to powder by pounding in an iron mortar; then by rubbing in cow's

urine and roasting the powder in a covered crucible by a process known as Gajaputa the mass was reduced to a fine impalpable powder. This process of roasting the iron was repeated until it became so finely powdered that it floated on the surface of water and did not irritate the eyes when it was dropped in the conjunctival sac. For ordinary purposes the roasting was repeated ten times, but it was believed that the medicinal virtue of iron would be increased by the number of times it was roasted. This iron roasted one thousand times was said to possess supreme virtues and was highly effective in many pathological conditions. The resulting preparation, which in all probability was a mixture of different salts or oxides of iron formed by its interaction with the different ingredients with which it was mixed during the so-called process of purification, was termed Lauha Bhasma. Various other methods have also been described for the preparation of the same drug, but they need not be given here. It will be sufficient to say that all these methods were very elaborate and the resulting products were in consequence complicated.

The present investigation was undertaken with a view to determine the composition of Lauha Bhasma and, if possible, to find out the rationale of its administration in different diseases in the light of our modern conception of therapeutics.

CHEMICAL COMPOSITION.—A sample of Lauha Bhasma supplied by the Kalpataru Ayurvedic Works of Calcutta was analysed. It was a dull red amorphous powder with a very slightly saline and astringent taste. The chemical composition found as the result of our qualitative and quantitative analyses is given below:

	Per Cent.
Ferric oxide (Fe_2O_3)	87.030
Ferrous oxide (FeO)	2.850
Silica (SiO_2)	7.338
Phosphorous pentoxide (P_2O_5)	0.338
Magnesia (MgO)	0.083
Lime (CaO)	0.363
Chlorides as (NaCl)	0.455
Potash (K_2O)	0.012
Sulphuric anhydride (SO_3)	0.240
Moisture, etc.	0.391
Total	100.000

The solubility of Lauha Bhasma in dilute hydrochloric acid of a strength approximating that found in the gastric juice was also studied. For this purpose a known weight of the sample was digested in 200 c.c. of 0.3 per cent. of HCl at a temperature of 37°C . for 24 hours. The quantity dissolved amounted to 3.901 per cent. and it was found to consist of the following:

	Parts
Ferric oxide (Fe_2O_3)	1.033
Ferrous oxide (FeO)	1.097
Silica, (SiO_2)	0.435
Phosphorus pentoxide (P_2O_5)	0.198
Magnesia (MgO)	0.080
Lime (CaO)	0.348
Potash (K_2O)	0.012
Sulphuric anhydride (SO_3)	0.240
Chlorides as (NaCl)	0.458
Total	3.901

We have also treated a known weight of the samples with boiling water and found that only 1.61 per cent. of the substance dissolved in it. The water soluble portion consisted of traces of iron and mainly of chlorides of sodium, potassium and lime.

THERAPEUTIC USES.—It is a well known fact that the ancients employed iron in the treatment of such diseases as anaemia and debilitating conditions. They introduced it into the body by making the patients drink water in which swords have been allowed to rust, but it is difficult to conceive whether they knew anything regarding the part it played in the metabolism or whether they had some sort of obscure notion that the strength of steel would pass into the patients by this means. Celcus advised the treatment of enlarged spleen in a somewhat similar manner by drinking the water in which glowing iron is drenched in the smithies (which probably contain collidal iron oxides) because he observed that domestic animals reared near these smithies and which drank this water had small spleen. The ancient Hindus, however, appeared to possess a more advanced knowledge of the uses of iron. This is obvious from the elaborate way in which iron preparations such as Lauha Bhasma were prepared. The Hindu Physicians probably appreciated that iron preparations should be administered in an assimilable form. In case of Lauha Bhasma, or calcined iron, this was done by the so-called process of purification which really meant nothing more than conversion into oxides. The salts of organic acids which were of the nature of citrates and tartrates are also suitable from the point of view of administration. The idea of reducing these preparations to very fine impalpable powders, which probably helped the formation of the colloidal state, was also rational as in this way these could be easily acted on by the gastric and other juices and rendered absorbable, at the same time they would produce very little irritant and astringent effects on the gastro-intestinal tract. The conditions in which the iron preparations were prescribed can also be understood in the light of the present state of our knowledge. They were mainly employed in the treatment of such diseases as anaemia and debilitating conditions in which the functions of the haemopoietic system were disturbed and consequently the blood became deficient. The role of iron in the treatment of anaemias is now better understood and a large number of excellent preparations are available for therapeutic purposes. These can be effectively administered without producing any untoward effects and there seems to be no advantage in using crude preparations such as have been described above, which undoubtedly served their purpose when preparations as at present were not available.

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(1) Ainslie, W., 1826, *Materia Medica*; (2) Dutt, U. C., 1922, *Materia Medica of the Hindoos*; (3) Khory, R. N., and Khatrak, N. N., 1903, *Materia Medica of India and their Therapeutics*; (4) Sen Gupta, N. N., 1911, *Ayurvedic System of Medicine*; (5) Watt, G., 1889-1904, *Dictionary of Economic Products of India*; (6) Chopra, R. N., Ghosh, S., Dutt, A. T., 1936, *Ind. Jour. Med. Res.*, 517.

MAKARADHWAJA

Makaradhwaja is a well-known inorganic preparation of the Hindu Pharmacopoeia. Its use can be traced to the time of Bhabamisra, the renowned Hindu physician, who lived in the early part of the 16th century. Since then, the preparation has been in constant use and is to this day held in very high esteem by the Ayurvedic practitioners. This drug has such a great hold on the minds of the people in India that many practitioners of the Western medicine also use it. There is probably something of real value about it as it has resisted the ravages of time for many centuries and is universally esteemed to the present day. An enquiry into the mode of action of this remedy may, therefore, prove beneficial and with this idea in view, we have thought it worth while to introduce a short discussion on it so as to draw the attention of the research workers.

PREPARATION OF MAKARADHWAJA.—It is necessary at the outset to outline the process of preparation of this drug, as according to the Ayurvedic pharmacopoeia a great deal depends on the method adopted. Various methods have been described in books on Hindu medicine. The description given below has been kindly given to us by an eminent practitioner of the Ayurvedic medicine in Calcutta and is believed to be the standard method laid down in books of the Hindu materia medica.

Eight parts of pure mercury and one part of gold leaf are mixed together to form an amalgam. To this mixture, sixteen parts of sublimed sulphur are added and the resulting mixture is rubbed very thoroughly in a stone mortar for 24 hours or more until the whole is converted into a lustreless, fine, impalpable powder of uniform consistence. This powder should be light enough to float on water and there should be absolutely no lumps or grit in it when rubbed between the fingers. This is known as 'kajjali' in Sanskrit and its chemical composition is said to be the same as black sulphide of mercury. This preparation forms the basis for the 'makaradhwaja'. The 'kajjali' is placed in a narrow-mouthed bottle and is gradually heated on a sand bath. When the temperature reaches a certain limit the bottle is filled with reddish fumes of various hues. On cooling 'makaradhwaja' is found deposited on the inner surface of the bottle. The sublimed powder is collected by breaking the neck of the bottle and scraping off the deposit, which is then preserved in a clean dry vessel for future use.

A great deal of stress has been laid by the Hindu physicians on the purification of mercury employed for the preparation of this drug. The mercury used has to be passed through various methods of purification laid down in the Ayurvedic books before it can be accepted for use. These processes are known as 'sodhana'. It may be mentioned in this connection that the processes described for 'sodhana' are very tedious and complicated. Judged from the standpoint of modern chemistry, these methods of purification have very little to recommend them and in many instances impurities from extraneous sources are actually introduced in the different stages of the processes, rather than removed.

ADMINISTRATION OF MAKARADHWAJA IN HINDU MEDICINE.—Makaradhwaja is seldom used alone. In the majority of cases, it is mixed with various drugs called 'anupana' or adjuvants. Thus in cases of indigestion and diarrhoea, 'makaradhwaja' is mixed with powdered 'bael' fruit (*Egle marmelos*); in cases of fever and cough it is given with the juice of ginger, betel leaves (*Piper betle*) and 'tulsi' leaves (*Ocimum viride*); in heart disease it is combined with musk. In the absence of proper 'anupana' (adjuvant) honey may be used in every case. The usual procedure is to take a dose (approximately one grain) of 'makaradhwaja' with 60 drops of the 'anupana' or honey and rub it for sometime in a stone mortar before administration. The medicine may be used both for adults and children, the dosage being regulated according to age. 'Makaradhwaja' when taken regularly is believed in the indigenous system of medicine to be a wonderful tonic and is said to increase the longevity of the patient.

THE COMPOSITION OF MAKARADHWAJA.—Chemically, 'makaradhwaja' is identical with the red sulphide of mercury. This sulphide occurs in nature as the mineral ore called *cinnabar* in many parts of the world particularly in California, China and Spain. In the vernacular, cinnabar is known as 'hingool' and is to be found in Nepal. 'Hingool' found in the Calcutta market is not the natural ore, but is artificially prepared by heating mercury with sulphur in a retort. This substance, except for the slight impurities which it might contain, has the same composition as 'makaradhwaja'. In the Ayurvedic practice, however, 'hingool' and 'makaradhwaja' are claimed to possess entirely different properties. Not only is it considered different from 'hingool' (the natural red sulphide of mercury), but it is also thought to be different from the artificial sulphides of mercury like 'kajjali' and 'krishna-parpati' (both of which resemble black sulphide of mercury in composition) and 'rasa-sindura' (red sulphide of mercury). These differences are rather difficult to explain from the modern scientific point of view. It is claimed by the Ayurvedic practitioners that 'makaradhwaja' is not ordinary red sulphide of mercury but is a combination of sulphide of mercury with gold. This gold is not in a chemically combined condition but its presence in a very fine state of division alters the property of the drug to a considerable extent.

PHARMACOLOGICAL ACTION.—Most of the soluble salts of mercury are absorbed slowly from the intact mucous membrane of the alimentary tract and produce their systemic effects. The insoluble mercurial salts, however, are very sparingly absorbed. Mercurous chloride and mercurous iodide are known to be absorbed as mercury can be detected in the urine after their administration. It has been found that after administration of 0.6 gm. of calomel and 20 mg. of mercurous iodide daily, 5 mg. and 4 mg. of mercury respectively are excreted in the urine. In the case of sulphides, however, a great deal of doubt exists as to whether they are absorbed at all. The sulphide ion is very inert and it is clear that unless and until, the salt is dissociated into its constituent ions, mercury will not be able to exert its influence on the body tissues. Sulphide of mercury is not used in any of the Pharmacopoeias of Western countries as it is considered to be devoid of therapeutic activity. This

idea gains additional support from the fact that the various mercurial salts after absorption are excreted into the caecum and colon as sulphides and in this form, mercury is found in the faeces. In the Ayurvedic Pharmacopoeia, on the other hand, mercury is predominantly used in the form of sulphides. It is indeed strange that a country, where this metal was first harnessed into the service of medicine, should have chosen an insoluble and possibly an inert salt for therapeutic uses. Investigation was therefore carried on to determine whether this salt is at all made soluble under ordinary physiological conditions in the gut and whether the mercury ion liberated from this so-called inert combination can be utilised by the tissues.

EXPERIMENTAL.—Ghosh (1931) has recently shown that 'makardhwaja' and other sulphides of mercury in a fine state of division undergo solution in 5 c.c. of a 0.2 per cent. solution of HCl at 100°F. in an hour. This is also true when these sulphides are digested with filtered gastric juice obtained artificially from a healthy patient. If sulphide of mercury is broken up in this manner by the acid of the gastric juice, it is likely that absorption will take place. By feeding a young dog with finely powdered 'makardhwaja' once a day for three consecutive days, he has further shown the presence of mercury in the liver. From these observations, he concludes that the insoluble sulphides are changed into soluble chlorides by the action of the gastric juice and in this form mercury is absorbed into the system *via* the portal circulation and stored up in the liver and other organs. This observation was based on only one animal experiment and cannot, therefore, be considered a definite proof of the absorption of the metal. In order to confirm the findings, the absorption of the drug from the stomach and intestines was studied by the following methods. The abdominal cavity of guinea pigs was opened under ether anaesthesia in the epigastric and iliac regions as required and sterilised catgut ligatures were placed at the pylorus in three animals and at the ileo-caecal junction in two other animals. An incision was made into the wall of the stomach and finely powdered 'makardhwaja' suspended in honey was introduced directly into the cavity through the wound. The abdominal wounds were sutured and the animals allowed to recover from the anaesthesia. After this operation, the animals generally died within 24-30 hours. *Post mortem*, the small intestines and the colon were ligated separately and their contents examined for the presence of mercury. Under ordinary circumstances, if the insoluble sulphide of mercury is converted into the soluble chloride and is absorbed into the system, it would be possible to obtain some evidence of the presence of mercury either in the liver where it would have been stored or in the colon washings where it would have been excreted. As nothing has been allowed to pass through the pylorus in the first three animals and through the ileo-caecal valve in the other two, the presence of mercury in the colon would be a fairly reliable indication of its absorption and circulation in the blood. In all the guinea pigs where 'makardhwaja' was introduced into the stomach in the manner described above, we could not detect the metal in any of the washings from the intestinal tract, neither was there any definite indication of its storage in the liver, at least in sufficient amounts

to be distinguishable by the ordinary chemical tests for mercury. From these experiments, it may be said that mercury in the form of 'makaradhwaja' is not absorbed either from the stomach or from the small intestines. It is, however, likely that very minute quantities are absorbed and excreted and the ordinary chemical tests are not sensitive enough to detect its presence. Further investigations with improved methods of identification of mercury are therefore called for.

Excretion of the drug was next studied as the rate of elimination is a very good index of the rate of absorption and presence of a drug in the blood and tissues. 'Makaradhwaja' was obtained from reliable sources as most of the preparations in the market are said to be adulterated. It was administered to several healthy patients in doses of 1 to 2 gr. (65 to 130 mg.), following strictly the directions of the Ayurvedic practitioners. The drug was thoroughly rubbed in a stone mortar for about 15 minutes before administration to convert it into a fine, impalpable glossy powder and was mixed with pure honey as a vehicle. It was given daily for one week. After the first 3 days, samples of the urine were collected daily and examined according to the methods to be described later. Individual samples as well as samples from 24 hours collections (kept with toluene to prevent decomposition) were examined. Most of the patients were our laboratory assistants who were healthy young men and were under strict control.

In such a study, the excretion of the metal in both the urine and faeces has to be considered. Most of the analytical methods of estimation of the metal in vogue contain inherent faults and any conclusions drawn as a result of estimation by these methods, are likely to be fallacious. Booth, Schreiber and Zwick (1926) have described a new analytical method which has been claimed to yield accurate results and permits of the estimation of 5 mg. or less of mercury in a litre of the solution in presence of organic matter. In principle, it consists of the oxidation of the excreta by digestion with sulphuric acid and potassium permanganate, precipitation of the mercury as sulphide and enmeshment of the precipitate by gelatinous manganic hydroxide. The washed and dried precipitate is ground up with lead chromate and decomposed by heating in a glass tube at 550°C. for 3 hours. The volatilized metallic mercury is condensed in the cooler portion of the tube. When the entire mercury has separated, it is collected into one globule, transferred to a calibrated capillary tube, the length of the column measured micrometrically and transposed to the corresponding weight. As this method entails the selection of cases who have to be kept under strict hospital supervision for the purpose of collection of the daily excreta for weeks, mercury excreted in the urine was estimated as a preliminary measure. The method which is a slight modification of the original Bardach's method, was used.

In seven healthy individuals experimented upon, no traces of mercury could be detected in the urine by this method.

THERAPEUTIC USES:—‘Makaradhwaja’ is commonly used as a tonic in debilitating conditions and in convalescent patients after acute illness. In failing circulation and in cardiac asthenia, ‘makaradhwaja’ is considered to be a sovereign remedy. Recent work has shown that the mercury ion in a high state of dilution has a definite stimulant action on animal tissues. One in one million of mercuric chloride added to the perfusate distinctly stimulated the isolated mammalian heart and increased its force of contraction. It is therefore likely that if absorption does take place in very small quantities, ‘makaradhwaja’ would produce a stimulant action on the heart.

In view of this work, the drug was tried in some cases of myocardial disorders following acute specific fevers. That there was distinct clinical improvement in the condition of individual patients after the administration of the drug for a period of 15 to 20 days, there seemed little doubt but extended trials are necessary before a definite opinion can be given. Mercury preparations have been used for many years as tonic and alterative in the western medicine. There seems to be very good reason for such use as it has been shown that small doses of mercury diminish the amount of oxidation of the tissues, as evidenced by the variations in the gaseous interchange. Further, the administration of small doses of mercury to rabbits, dogs and men causes an increase in the number of red blood corpuscles while the body gains in weight and the general nutrition is improved. Larger doses, however, have been found to act in the reverse way by causing a diminution in the amount of haemoglobin, in the number of corpuscles and in the weight. Most of the preparations of mercury in use in the British Pharmacopoeia are rapidly absorbed, so that larger quantities of mercury ion than are good for the system, are probably taken up. It is quite possible that in ‘makaradhwaja’ we have an insoluble preparation which by action of the gastro-intestinal juices is rendered absorbable to such an extent that minute quantities of mercury ions sufficient for stimulation of the tissues and no more, are taken into the system and are acting on the tissues.

‘Makaradhwaja’ is also used as a laxative with good results particularly in those cases when there is visceroptosis and atonic condition of the gastro-intestinal tract. As an intestinal antiseptic also, it is said to be of great utility and is supposed to relieve the gaseous distension of bowels due to fermentation. How far this is true has yet to be investigated, but mercury is known to be a powerful and readily diffusible protoplasmic poison which acts in very high dilutions against lower forms of life. Recent researches on the intestinal antiseptics have shown that calomel is one of the few drugs which produces alteration in the intestinal flora and brings about an appreciable decrease in the bacterial contents of the gut. In view of these facts it is not unlikely that the claims made for ‘makaradhwaja’ in this connection may be borne out by further research.

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RAUPYA BHASMA (Reduced Silver)

The use of silver in the indigenous medicine of India dates back to remote antiquity. Its Sanskrit name Raupya is found in many of the early works of Hindu medicine and there is ample evidence in the literature to show that silver held an important place in therapeutics. Its use was, however, not extensive as compared with metals like iron and tin and the number of preparations was limited.

PREPARATION OF RAUPYA BHASMA (REDUCED SILVER).—Like all other metallic preparations of Ayurvedic medicine, silver is also used in the form of crude compounds formed after subjecting it to complicated processes of so-called 'purification' which convert it to fine greyish black powder. The methods used for the 'purification' and reduction are numerous. Some of the more important ones are given below:

(1) Silver is 'purified' for preparing its 'ash' by melting it with lead and borax. (2) Thin sheets of silver are heated to redness and steeped thrice in each of the following: viz. oil, whey, kanji, cow's urine, and extract of Kulatha Kalai (*Dolichos uniflorus*). The metal thus 'purified' is suitable for entering into the composition of medicinal preparations. The sheets of purified silver are smeared with Kajjali, which is prepared by mixing two parts of sulphur and one part of mercury ground with the juice of Jambira (*Citrus acida*). It is then heated in Gajaputa. The product thus obtained is called Raupya Bhasma or reduced silver. (3) Silver leaves as purified above are cut into small pieces and powdered with equal quantity of mercury. It is next pounded with juice of *Citrus medica* and subjected to the process of roasting known as Putapaka. By repeating the process thrice pure 'ashes' of silver may be obtained. (4) A paste is made by mixing powdered orpiment and another paste is made by mixing powdered pomegranate bark, acacia leaves and juice of aloe leaves (*Aloe indica*). These two pastes are thoroughly mixed and a bolus is made with it. In the centre of this, pure refined silver leaf is placed in the shape of a ball and the whole is covered with clay. It is then roasted and then calcined. (5) Silver leaf is rubbed with mercury and the juice of *Aitrocarpus lukucha*. The resulting paste is then embeded in sulphur and heated in a covered crucible in a sand-bath. When cold, the mass is once rubbed with orpiment and acid and roasted twelve times. By this process the silver is reduced to an ash-like substance. (6) Four parts of silver leaves are rubbed with one part of orpiment and lemon juice and the mixture is roasted. The process is repeated 14 times and thus the silver is completely reduced. (7) Silver leaves are mixed with twice the weight of cinnabar heated in the subliming apparatus called Urdhapatan Jantra. This process is repeated 14 times and the resulting compound is a fine greyish black powder with minute shining white particles intermixed with it.

A sample of Raupya Bhasma obtained from the Kalpataru Ayurvedic Works, Calcutta, was subjected to analysis. In appearance it was a greyish-black amorphous powder with an admixture of very small white particles. Its chemical composition as the result of our qualitative and quantitative analysis is given below:

	Per Cent.
Silver metallic	69.670
Sulphur	14.805
Ferric oxide (Fe_2O_3)	7.830
Alumina (Al_2O_3)	2.250
Cupric oxide (CuO)	0.890
Phosphate (P_2O_5)	1.080
Silica (SiO_2)	1.160
Lime (CaO)	0.880
Potash (K_2O)	0.141
Soda (Na_2O)	0.054
Sulphuric anhydride (SO_3)	0.935
Moisture and other constituents	0.304
Total	100.000

According to some authors Raupya Bhasma is an impure oxide of silver. The sample analysed by us proved to be more of the nature of a sulphide. This difference in composition may be due to the different methods of preparation used. The preparation according to the methods (2) and (3) in which little or no sulphur had been used give the oxide, whereas the other preparations would give the sulphide.

PHARMACOLOGY AND THERAPEUTICS.—Raupya Bhasma being an insoluble inorganic compound, its pharmacological action is difficult to test. To test the popular belief regarding the therapeutic efficacy of Raupya Bhasma in nervous disorders, e.g., epilepsy, chorea, neuritis, an attempt was made to see whether it has had any effect on peripheral nerves. A nerve muscle preparation of the gastrocnemius muscle of the frog was treated with a 3 per cent. suspension of the drug in normal saline and the nerve impulse changes were recorded by means of an oscillograph. Preliminary experiments showed that there was no change of impulse frequency when the muscle alone was exposed to Raupya Bhasma suspension as compared with the normal control. On the other hand, when the nerve fibres were bathed in the suspension, the discharge frequency showed a slight diminution. Though these results cannot be considered definitely indicative, they are suggestive and indicate that the supposed action of silver on the nerves is not purely based on popular belief but may have some scientific basis.

In modern therapeutics the use of silver is not extensive. Silver preparations are generally used externally for removal of newly formed tissues, especially chronic inflammations and ulcers. The main principle of its therapeutic use consists in the capacity of silver to combine chemically with proteins to form proteinates. In silver nitrate, the concentration of silver-ions is high and the destruction of tissues is more drastic and hence it acts as a caustic. Where milder preparations, are required, silver proteinates, e.g., silver caseinates, or colloidal silver preparations, are used since they contain a much lower concentration of ions than electrolytic salts of silver. The use of silver in the nervous diseases originated with the Arabs probably from the influence of astrology in the medicine of that period. It was thought that nervous diseases were especially affected by the phases of the moon which was associated with silver in their system, hence the names lunar caustic, lunacy etc. In the Indian indigenous medicine, Raupya Bhasma is not only used against inflammation of the mucous membranes, but also in the treatment of neuritis and neuralgia. It is believed to have a soothing effect on the nerves including the peripheral nerve-endings. It is administered by the mouth in combination with different correctives which differ from different diseases. It is seldom used alone but is often used in combination with iron, tin and gold. Modern research has shown that silver is not absorbed in sufficient quantity from the alimentary canal to produce any systematic effects. Its use in various diseases, therefore, has been entirely given up. Long continued use has been shown to produce blackish discoloration of skin called argyria due to the deposition of minute silver particles, probably in organic combination. Traces must, therefore, be absorbed, but these become fixed in the tissues in inert form.

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SAMUDRA PHENA

The name Samudra Phena is derived from the words Samudra (sea) and Phena (foam), as it is generally believed to be the dried foam of sea water. In reality, it is the calcareous shell of a sea fish, probably of *Sepia officinalis*. The shell is oblong or elliptical and is very hard and brittle. The outer surface is smooth and composed of thin flat pieces about 0.5 mm. in thickness arranged one above the other in a heap of thin layers, each layer being separated from the other by longitudinal ridges. It can be easily scratched and pulverised. The inner surface is hard, porous and easily friable. Samudra Phena is used in Ayurvedic medicine and is a very common household remedy in India. In earache and oedema around the external auditory meatus a paste made with samudra phena and the juice of *Datura fastuosa* is said to be highly beneficial. A powder made from Samudra Phena is also dusted into the ear to relieve earache and otorrhoea. A medicated oil is prepared by boiling its fine scrapings in sesame oil which is used in earache. In skin diseases, it is applied locally with lime-juice and with rose-water, it is applied to the body in prickly heat. According to a well-known Ayurvedic physician of Calcutta who had kindly supplied us a genuine specimen of the drug for our analysis, it is a rich and cheap source of organic calcium and is used both externally and internally. In Ayurvedic practice, its internal use is not commonly recommended, but it has been found to be very effective internally and is considered to be better than calcium lactate. The dose is from 5 to 15 grains.

CHEMICAL COMPOSITION.—The sample sent for analysis was a white lump, elliptical in shape. It was finely powdered and intimately mixed before making the qualitative and quantitative analysis. The result of quantitative analysis is as follows:

	Per Cent.
Lime (CaO)	49.725
Silica (SiO ₂)	0.580
Iron (Fe ₂ O ₃)	0.324
Alumina (Al ₂ O ₃)	0.102
Phosphoric acid (P ₂ O ₅)	0.048
Carbon dioxide (CO ₂)	38.560
Sodium chloride (NaCl)	1.670
Potash (K ₂ O)	trace
Magnesia	trace
Sulphates	trace
Moisture	3.925
Organic matter	0.066
TOTAL	100.00

The amount of nitrogen in the organic matter amounted to 0.364 per cent. of the total. Of the total calcium present, 49.076 per cent. is combined with carbon dioxide as calcium carbonate and the balance 0.649 per cent. probably as organic calcium.

PHARMACOLOGY AND THERAPEUTICS.—Being an insoluble inorganic preparation, the pharmacological action could not be studied in the usual manner. From the nature of the constituents, it is expected to be of some clinical use, both externally as an astringent and internally where calcium is indicated. An impure and uncertain product like this does not, however, offer any special advantage over several pure salts of calcium now being used in medicine.

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(1) Khory, R. N., and Khatrak, N. N., 1903, *Materia Medica of India and its Therapeutics*; (2) Sen Gupta, N. N. 1911, *Ayurvedic System of Medicine*; (3) Chopra, R. N., Ghosh, S., Dutt, A. T., 1938, *Ind. Jour. Med. Res.*, 485.

SILAJIT

ASPIIALT; MINERAL PITCH

VERN.—Sans.—*Silajit*, *Silaras*; Hind., Guj. and Mar.—*Silajita*; Beng.—*Silajatu*; Tam.—*Uerangyum*; Arab.—*Hajar-ul-musa*.

Silajit is an exudation from rock-surface obtained in certain parts of India during the months of May and June when the weather is very hot. It is found in abundance in the lower Himalayan hills near Hardwar, Simla, and also in Nepal. Large quantities of it are imported into India from Khatamandu. A white variety is said to be collected from rocks in Mount Abu. It may be mentioned here, however, that alum earth of Nepal which is sold in Calcutta as *white silajit* is quite a different substance from the *silajit* used in the Hindu materia medica. Four varieties of *silajit* are described by the ancient Hindu writers: (1) the *gold silajit* which is red; (2) the *silver silajit* which is white; (3) the *copper silajit* which is blue coloured; and (4) *iron silajit* which is blackish brown. Blue and red *silajit* are not found commonly and the variety mostly available is the fourth variety which, from the therapeutic point of view, is considered to be active. The author's investigations were, therefore, mainly confined to this variety.

Silajit is an important drug of the ancient Hindu materia medica and is extensively used by the Hindu physicians in a variety of diseases. It is said to be efficacious against phthisis, chronic bronchitis and asthma, digestive troubles, renal and bladder calculi, dropsy, nervous diseases, leprosy, diabetes, fracture of bones, etc. It is also used as an antiseptic in parasitic diseases of the skin and as an antiphlogistic. The Mohammedan physicians included it in their materia medica three centuries ago and used it as an antidote to poisons and in the treatment of disease. A similar product called 'Momia' is obtained from some of the mountains in Arabia and Persia and is extensively used by the hakims as an external application for inflammatory swellings, arthritis, etc.

CHEMICAL COMPOSITION.—The general appearance of *silajit* is that of a compact mass of vegetable organic matter composed of a dark-red gummy matrix interspersed with vegetable fibres, sand and earthy matter. The gummy substance dissolves in water and when washed away leaves an earthy matter, vegetable fibres and a few black round button-like masses

(1/8 in. in diam.) resembling peas. The insoluble matter is removed by straining through a thick cloth or flannel. The fluid is allowed to stand in the sun when a creamy substance rises to the top. The purified silajit (*shodhita*) is just like the concentrated watery extract of the crude stuff. Both the crude and purified samples have a decided urinous odour and slightly bitter, saline, somewhat pungent and astringent taste. The purified substance is nearly completely soluble in water and has an acid reaction.

Hooper was the first to analyse *silajit* and the results of his analysis are as follows:

Water	..	8.85	Nitrogen	..	1.03
Organic matter	...	56.20	Lime	.....	7.80
Mineral matter	.	34.95	Potash	..	9.07
		<hr/>	Phosphoric acid	....	0.16
		100.00			

The organic matter yielded to spirit a small percentage of brownish coloured wax-like substance which melted on heating and burnt away with a smoky flame. It retained the peculiar odour of the drug and had no marked taste. It was neutral in reaction and did not assume a crystalline structure when carefully evaporated from alcoholic solution. The tests would indicate the presence of a mineral hydrocarbon of a bituminous nature. The bulk of the dark brown organic matter had the properties of humic acid. The drug, from a chemical point of view, should have some valuable manurial properties.

WHITE SILAJIT.—A sample of white silajit, which is considered to be more effective than the black variety, was also examined by this worker. It was a cream-coloured crystalline compound with a strong nauseous odour. It was apparently of animal origin and afforded gaseous ammonia when mixed with slaked lime. It yielded 64 per cent. of pure urea when determined from the amount of nitrogen given off by means of hypobromite of sodium. It appeared to be crude urea or evaporated urine in a solid state.

A careful analysis of the ordinary silajit was carried out by the author and his co-workers. It does not contain any compound of the nature of an alkaloid. The following table shows the percentage of dried extracts after distilling off the solvent.

Solvent.	Crude <i>Silajit</i> amount dissolved	Purified <i>Silajit</i> amount dissolved
Chloroform	.. 2.15 per cent.	5.88 per cent (cryst.)
Ethyl acetate	.. 1.12 " "	1.37 " "
Alcohol (80 per cent.)	... 29.25 " " (cryst.)	30.81 " " (cryst.)
Water	.... 22.66 " "	28.32 " "

Both the alcoholic extracts crystallised after several days and were found to contain benzoic acid; the ash left after ignition showed the presence of a larger quantity of lime. The crystals under the microscope looked like those of calcium benzoate. The ethyl acetate extract was crystalline in nature. It contained a substance soluble in alcohol and partially soluble in hot water, but practically insoluble in ether and chloroform. The crystals had a melting point of 187°C. and were identified by further examination to be those of hippuric acid.

The results of the analysis shows that silajit is composed of the following substances:

ORGANIC CONSTITUENTS

	Crude <i>Silajit</i> per cent.	Purified <i>Silajit</i> per cent.
Moisture	12.54	29.03
Benzoic acid	6.82	8.58
Hippuric acid	5.53	6.13
Fatty acids	2.01	1.36
Resin and waxy matter	3.28	2.44
Gums	15.59	17.32
Albuminoids	19.61	16.12
Vegetable matter, sand, etc.	28.52	2.15

Moisture was determined by drying the substance in the steam oven at a temperature not exceeding 90°C. Albuminoids were calculated from the total nitrogen, determined by Kjeldhal's process (modified) after deducting the percentage of nitrogen in the hippuric acid present.

The mineral constituents, as obtained from the ash by incineration of the substance at a dull red heat, are also appended in the following table:

	Crude <i>Silajit</i> per cent	Pure <i>Silajit</i> per cent.
Moisture	12.54	29.03
Loss on ignition	64.58	52.63
Ash	22.88	18.34
Silica (residue insoluble in HCl)	4.60	2.69
Iron (Fe ₂ O ₃)	0.51	0.64
Alumina (Al ₂ O ₃)	2.26	2.61
Lime (CaO)	6.83	4.82
Magnesia (MgO)	1.29	1.20
Potash (K ₂ O)	4.60	3.81
Sulphuric acid (SO ₃)	0.64	0.97
Chloride (NaCl)	0.26	0.57
Phosphoric acid (P ₂ O ₅)	0.28	0.24
Nitrogen	3.64	3.36

From a comparison of the above results, it appears that there is not much difference between the crude and the purified *Silajit*. The crude stuff leaves a residue after extraction with water which amounts to about 30 per cent., whereas the residue in the purified drug is only about $\frac{1}{3}$ per cent. This may lead one to suppose that the purified *Silajit* contains more extractives than the crude form. This would have been the case were it not for the fact that the high percentage of moisture in the purified substance counter-balanced the insoluble matter in the crude stuff. The main point of difference between the varieties is that the chloroform and ethyl acetate extracts of the purified substance deposit crystals of benzoic and hippuric acids, but there are none in similar extracts made from the crude *Silajit*. It would appear, therefore, that a portion of the benzoic and hippuric acids remains free in the purified *Silajit*. Probably the salts of the benzoic and hippuric acids in the crude *Silajit* are hydrolysed during the process of purification.

From the physical characteristics and from a microscopical examination of the residue left after extraction with water, which was mainly composed of sand, earthy matter and vegetable fibres, *silajit* would appear to be a substance of vegetable origin. Its chemical composition, however, shows the presence of hippuric acid and a high percentage of albuminoids, which makes this supposition doubtful. If hippuric acid is formed from the decomposition and decay of vegetable proteins substances without animal intervention, the amount of proteins must be in unusually higher proportions than is ordinarily met with in the vegetable kingdom. It is well-known that benzoic acid can be easily formed from hippuric acid, in fact this is one of the commercial methods of its manufacture. It is further found that benzoic acid manufactured from hippuric acid possesses a decided urinous odour and we have already mentioned that the crude and the purified *silajit* possess this odour. The presence of gum and resin is also a point in favour of its vegetable origin. The other possibility is that *silajit* may be composed of the excrements of some animals which have been washed off by the rains from the hill-side and have been deposited in the crevices and low-lying

rocks. During the summer the heat of the sun removes the moisture and leaves the residue like an exudation on the rock. The whole of the subject of the production of silajit requires further investigation.

THERAPEUTIC USES OF SILAJIT.—Of all the remedies used by the Hindu physicians against diabetes, silajit is said to be one of the most efficacious. It is said that 'under its influence thirst, polyuria, burning sensation and exhaustion disappear quickly'. It markedly helps the assimilation of sugar. The Hindu physicians use the drug in combination with milk or grape juice. Purified silajit is also recommended to be soaked in the decoctions of one or more of the following plants as this is said to increase its efficacy. *Shorea robusta* (sala), *Buchanania latifolia* (piala), *Terminalia tomentosa* (asana), *Acacia farnesiana* (acacia), *Catechu nigrum* (catechu), *Terminalia chebula* (myrobalan), and *Sida cordifolia* (bala).

We have tried the purified drug by itself in a series of cases of diabetes mellitus in order to see what effect it had in this condition. The patients were selected at random as they came to the hospital for admission. The total carbohydrate intake was fixed and kept strictly under control. The total quantity of urine in 24 hours was carefully collected, measured, and a part of it was examined every day for the quantity of sugar present. The blood sugar was also estimated from time to time. The patients were regularly weighed during the entire period of the trial.

After admission, the patients were put on a strict diet of known carbohydrate value and some time was allowed for the daily output of the sugar to run to a constant level. The patients were then put on increasing doses of silajit (in pill form) till a maximum of 30 gr. a day was taken during 24 hours. Careful observations on a series of diabetic patients showed that doses of silajit ranging from 5 gr. to 10 gr. three times a day, for a period of 8 to 12 days, had no effect whatever either on the blood sugar or sugar in the urine. There was no decrease in the total quantity of the urine passed, and there was no amelioration of such symptoms as thirst, exhaustion, etc. The assimilation of carbohydrates was not improved in any way. The administration of insulin in these patients, rendered the urine sugar-free and the symptoms such as polyuria, thirst, etc., disappeared.

When applied externally, silajit has been credited with antiseptic, parasiticide, anodyne and antiphlogistic properties by the Hindu physicians. These are in all probability due to the free benzoic acid which it contains. It is well-known that benzoic acid which in concentrations of over 0.1 per cent. produces moderate local irritation, may in this way be useful as an application to sprained and bruised parts. Benzoic acid is also responsible for the beneficial action of silajit on the appetite and its use in dyspepsia. Its good effects in affections of the liver such as jaundice, its mild narcotic action, its anti-spasmodic effects in colics of all forms and spasms of muscular tubes and asthma may also be attributed to the presence of this acid and its salts. Silajit is used by the Hindu physicians in acute and chronic bronchitis and benzoic acid and benzoates are administered in these conditions in the Western medicine especially for children and to old feeble persons

with profuse thin secretion. It undoubtedly promotes expectoration, probably reflexly, by causing irritation of the throat and stomach. The Vaidyas prescribe the drug in arthritis and pulmonary tuberculosis; 30 years ago, benzoic acid and its salts enjoyed a reputation in the Western medicine as a remedy for these conditions, but were given up. The indigenous practitioners also used silajit as a diuretic and lithontriptic. Similar properties were attributed to benzoic acid in Western medicine. It will be seen, therefore, that most of the properties ascribed to silajit can be explained by the presence of benzoic acid and benzoates which are present in it in large quantities and which we consider are the main active principles of silajit.

Ray (1930) has shown that injections of extracts of silajit produce a rise in blood pressure and stimulation of respiration in experimental animals. He thinks that, as benzoic acid and benzoates are known not to have any action on the pulse and blood-pressure, there must be some other active principle in the drug which has not yet been detected by chemical analysis. He suggests that some unknown body or a pyridin derivative might be responsible. The experimental data given by this worker, however, do not appear to justify such a conclusion.

SUMMARY.—A fairly complete chemical analysis of silajit has been made. It contains besides gums, albuminoids, traces of resin and fatty acid, a large quantity of benzoic and hippuric acids and their salts. From the medicinal point of view, the chief active substances in it are benzoic acid and benzoates. The benefits ascribed to it by the Hindu physicians in different diseases may be attributed to this drug. Silajit has no effect either on the blood sugar or the urine sugar in diabetes.

References:—

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SWARNA BHASMA (Reduced Gold) and Gold Kusth

Gold as a metal has been known in India from time immemorial. Early works on old Hindu Medicine show that a number of preparations have been used in therapeutics for many centuries. Pure gold leaf or gold free from admixture of dust, copper, silver and other metals was usually employed, though in some preparations the metal was administered in the form of its salts or compounds. Swarna Bhasma is one of the commonest and a popular preparation. It is prepared in the following manner: The gold leaf is subjected to special treatment that goes by the name of 'purification'. The leaf is burnt in fire and the red hot metal is steeped seven times in each of the following: oil, whey, cow's urine, kanji, and extract of Kulatha Kalai (*Dolichos uniflorus*). There is more than one method of preparing the bhasma of which the following represent but a few:

- (1) In reducing gold one part of the purified metal and two parts of mercury are rubbed with an acid and made into a ball. Powdered sulphur equal in weight of the ball

is taken, half of the sulphur is placed in an earthen plate, the ball is placed over it and it is covered with the remaining half of the sulphur. The plate with its contents is covered with another earthen plate. A piece of rag is then smeared with clay and it is wrapped round the plate and dried in the sun. It is then placed on 30 pieces of dry cow dung cakes and roasted. The process is repeated 14 times when the gold converted into the bhasma form and is ready for use.

(2) Gold is reduced to a fine powder by rubbing with mercury and exposing it to heat in a covered crucible with the addition of sulphur. Two parts of mercury and one part of purified gold leaf are rubbed together into a mass with lemon juice and three parts of sulphur. The crucible is then covered and exposed to heat. The process of mixing gold with mercury and exposing the mixture so formed to heat is repeated 14 times when the gold completely loses its apparent metallic characters. Some are of opinion that gold should be rubbed with mercury when roasted for the first time and subsequent roasting should be done with sulphur alone.

(3) Another process of preparing reduced gold is that gold is melted and its own weight of ash of mercury is thrown into the molten metal. When cooled the mass is powdered and rubbed with lemon juice and cinabar and again roasted in a covered crucible. The process is repeated several times.

By whichever process gold is reduced the principles underlying the preparation is that it should be intimately mixed with mercury, sulphur, and citric acid and the mixture should be roasted several times. The reduced gold appears to undergo very little change from its metallic state, for on being rubbed on an agate mortar it produces a brilliant yellow stain like that of massive gold when the latter is rubbed on the touchstone for ascertaining its purity.

CHEMICAL COMPOSITION.—A sample of Swarna Bhasma obtained from the Kalpataru Ayurvedic Works Calcutta, was analysed. The sample was a full-brown amorphous with a metallic taste. On rubbing it over a hard surface it glistened and the physical character of gold was revealed. The chemical composition found as the result of our qualitative analyses is as follows:

	Per cent.
Gold, metallic	96.760
Silica (SiO_2)	1.140
Iron (Fe_2O_3)	0.140
Lime (CaO)	0.546
Copper	traces
Magnesia	traces
Phosphates (P_2O_5)	0.781
Potash (K_2O)	0.161
NaCl	0.078
Sulphates (SO_3)	0.150
Moisture	0.244
TOTAL	100.00

From this it appears that in the compound that we analysed gold was mostly present in the metallic state. Some oxide and sulphide of gold might be supposed to be present but owing to the instability of these compounds it is very difficult to accept such a conclusion, and even if they be present in it their quantities are obviously too small to be taken into consideration.

GOLD KUSTH.—This is a preparation of gold used in the Mohammedan medicine and the specimen examined was obtained from a well-known Hakim

of Delhi and had the reputation of being a wonderful nerve tonic. It was a greyish amorphous powder, insoluble in water. Qualitative tests showed that the whole of the gold contained was in a metallic state. On quantitative analysis it was found to contain 86.14 per cent. of metallic gold. The other inorganic constituents which amounted to 13.86 per cent. of the material could not be analysed in detail as the total amount sent for analysis was very small.

PHARMACOLOGY AND THERAPEUTICS.—Being an insoluble preparation, the pharmacological action of Swarna Bhasma and Gold Kusth could not be tested in the usual manner. These preparations consist mainly of metallic gold in a state of fine subdivision together with very small amounts of other compounds. The mode of administration of these preparations of gold, in the indigenous medicine consists of rubbing this powder in a mortar along with correctives that differ in different diseases and then it is taken by the mouth. The paste so prepared is composed mainly of metallic gold in a fine state of division. Such a treatment probably partly converts the insoluble powder into the colloidal state and it is possible that this colloidal gold is taken up by the system in minute quantities and produces effects in neurasthenia and other nervous affections. It is also possible that metallic gold in this form is acted upon by various secretions in the gastro-intestinal tract and may become converted into soluble compounds.

Soluble salts of gold, such as gold chloride, gold bromide, and potassium aurocyanide, have been used in modern medicine in a variety of diseases. Thus chloride of gold has been used both in the pure form and in combination with hydrochloric acid or sodium chloride, mainly in tubercular infections. The results are, however, still controversial, but it is believed in certain quarters that gold is effective in the early stages of tuberculosis. Gold bromide has been found to be very useful in epilepsy, while the potassium aurocyanide is believed to be useful in syphilitic infections. Besides these uses of the soluble salts of gold, colloidal gold has recently come into therapeutic use. Colloidal preparations have proved useful, particularly in epilepsy, alcoholic neurasthenia, and in the morphine habit (Stanford, 1924). Gold if taken internally in the metallic state produces toxic symptoms resembling those of arsenic, but in the colloidal state it has been found to be beneficial to the system.

According to a well-known Ayurvedic physician of Calcutta, Swarna Bhasma never produces any toxic symptoms. This is no doubt true as in the form in which it is present only very minute traces could be absorbed. It is believed to be a wonderful alterative and a tonic for the nervous system. It is an antidote to poisons, particularly those of bacterial origin. It is especially indicated in chronic fevers, tuberculosis and neurasthenia. The dose varies from $\frac{1}{4}$ gr. to 1 gr. but doses as large as 2 gr. are administered. In the Hindu medicine gold in the form of Bhasma is believed to be a sovereign remedy in heart disease and as a general tonic in anaemia and debility. It has been recommended in various forms of dyspepsia with pain in epigastric region and looseness of the bowels. Gold is also considered to be a powerful sexual stimulant and to act beneficially in impotency. It has also been used in excessive nocturnal emissions, in those

who masturbate. In the Mohammedan medicine Gold Kusth or gold in form of leaf is used for similar purposes. Gold beaten down to the very thin consistency, less than that of thin paper, is commonly used by people in such conditions. The effects produced may be partly physical but it is possible that minute quantities are absorbed and like some of the metals have a stimulating action on the metabolism as a whole.

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DRUGS OF ANIMAL ORIGIN

We have stated that Research on indigenous drugs has so far largely concerned itself with the vegetable *materia medica*. Drugs of animal origin and the various remedies for deficiency diseases and inorganic mineral compounds mentioned in the indigenous medicine have not received much attention. While modern medicine is turning to liver, stomach, insulin from the pancreas, fibrinogen from the lung and blood, albumin and gammaglobulin from blood, vitamin A from the eye and fish liver oils, adrenaline, thyroxine, parathormone, plasma, serum, vaccines, choline, etc., it is remarkable to find that many animal tissues, and organic glands such as, blood, bones, neck glands, heart, liver, lung, marrow, kidneys, pancreases, bile, urine etc., had been freely used in the indigenous system of medicine. Mention has also been made in ancient *materia medica* of crude remedies such as mung beans, walnut, pig's liver, etc. for night blindness and a condition akin to 'beri-beri'. This would tend to indicate that the ancients had made keen observations on conditions produced by vitamin deficiencies. Similarly, the recommendation for the use of large number of green and other plant sources containing vitamin C, such as capsicums, brassicas, pumelo and mustard leaves, in the diet of certain types of dental affections and skin conditions cannot be brushed aside as simply fortuitous coincidence. Indigenous remedies claiming to have power to prevent sterility and increase human fertility on the one hand and acting as oral contraceptives on the other are often associated with magical ideas. In view of the increasing volume of recent scientific work in this field, however, it is hoped that information may be forthcoming whereby these claims can be at least partly substantiated. Present knowledge justifies to some extent the claims for human placenta, marrow of animals, pig's pancreas and testicles, and pregnancy urine as aphrodisiacs and sex stimulants. The importance of inorganic mineral elements in foods and their function in maintaining body metabolism was apparently recognised and would be seen from the fact that many recipes are described containing bone powder, bone marrow, etc. which are rich in calcium

salts. Many foods rich in copper, and iron in organic form were recommended in treatment of diseases, which appear to be conditions caused by anaemia or pregnancy. Deficiency of iodine was definitely known to cause goiter and this has been used repeatedly in the treatment of 'swelled neck'.

MOSCHUS MOSCHIFERUS

MUSK

VERN.—Sans.—*Mriganabhi*, *Kasturi*; Hind.—*Kasturi*; Beng.—*Kasturi*; Tam. and Tel.—*Kasturi*; Mar. and Guj.—*Kasturi*; Burm.—*Kado*.

The term 'musk' is loosely applied to a number of products of both animal and vegetable origin characterised by the peculiar odour of the true perfume. Musk proper is the dried secretion from the preputial follicles of the musk-deer or *Moschus moschiferus*. The animals are found in China, Russia, Assam, Central Asia and in the pine forests and inaccessible cliffs of the Himalayas at elevations of about 8,000 ft. Musk is found in these animals only in the rutting season and is undoubtedly for the purpose of attracting the female. The season during which musk is present in the skin gland covers about one month and in order to secure the valuable secretion of the gland, the animal must be caught in that period. No musk is obtainable from animals in the other seasons of the year. The contents of the pod vary in bulk with the age of the animal. A yearling yields scarcely any musk, and a two-year-old fawn has in its skin gland contents one-eighth of an ounce of musk, which is milky, and has an unpleasant smell. A full-grown buck gives about two ounces, but specimens containing one-third to one-half of an ounce of musk are not uncommon. The material is found embedded in a sac which is oval or round with a diameter of about $1\frac{1}{2}$ in.; the upper surface is flat with a smooth membrane and the under surface is covered with stiff hairs arranged concentrically round a small opening. Though the quantity is small, the odour is so strong that it can be perceived at a distance when the animal is shot and it is said that the hunters very frequently suffer from the strong odour emanating from the fresh musk as it acts deleteriously on the nervous system, eyesight and hearing. Chinese traders say that the best kind of musk is not obtained from captured animals, but is gathered from the favourite haunts of the deer after the rutting season, when the animal breaks the gland with its hoofs and empties the contents on the ground. Musk of this kind is extremely difficult to obtain and is, therefore, rarely seen on the market.

MUSK IN THE ANIMAL AND VEGETABLE KINGDOMS.—It is interesting to note that odorous substances of the nature of musk occur both in the animal and vegetable kingdom in the different parts of the world. According to Gerardin, the following animals secrete musk or similarly odorous substances: The male musk-deer, *Moschus moschiferus*; the gazelle, *Antilope dorcas*; the marten, *Mustela foina*, the faeces of which are said to have a musk-like odour; the Alpine goat, *Capra ibex*, the dried blood of which smells like musk; the musk-ox, *Ovibos moschatus* which disseminates a decided musk odour and the meat of which, though it has a repulsive odour and taste, is eagerly eaten by the Indians; the zebu, *Bos indicus*; the pecari, *Dicotyles torquatus*; the musk-duck, *Anas moschata*, which is found on the Gold Coast, in Jamaica and Cayenne; the desman, *Myogal moschata*; the Nile crocodile,

Crocodilus vulgaris; various turtles, e.g., *Cinosternon pennsylvanianum*; and various Indian snakes.

The musk odour is also found quite commonly in the vegetable kingdom. It is found in *Malva moschata* and the seeds of *Hibiscus abelmoschus* Linn. (Malvaceæ) which are utilised in perfumery; *Brassica oleracea* Linn. var. *capitata* (Cruciferae); *Erodium moschatum*, Hér. and *Geranium triste* or *Pelargonium noctuolens* of Western Africa which is odorous at night (Geraniaceæ); *Rosa moschata* (Rosaceæ); the wax gourd, *Benincasa cerifera* Sav. and the Indian bottle gourd *Lagenaria vulgaris* Ser. (Cucurbitaceæ); *Adoxa moschatellina* Linn. (Caprifoliaceæ); *Achillea moschata* Jacq., *Aster argophyllus* Labill. and *Moschardia pinatifida* Mol. of Chile (Compositæ); *Hyssopus officinalis* Linn. and *Moschosma* species of India and Africa (Labiatae); *Mimulus moschatus* of Chile and North America (Scrophulariaceæ); *Moschorhizon scharzii* Juss., the musk wood of Jamaica (Meliaceæ); *Guarea grandiflora* of America and the poisonous *Serjania curassavica* Radlk. of America (Sapindaceæ); the wood of the American *Clusia eluteria* (Clusiaceæ); the Asiatic *Lawsonia inermis* Lam. (Lythraceæ); the East Indian *Ferula sumbul* Hook. (Umbelliferae); the wood of *Cordia rumphii* Bl. of Java (Boraginaceæ); *Pedaliium murex* = *Peturaga cingul* of Ceylon (Pedaliaceæ); *Cestrum nocturnum* Linn. of South America (Solanaceæ) and the Mexican wonder-flower, *Mirabilis longiflora* Linn. (Nyctaginaceæ), the last two named exhaling a musk odour at night.

Despite the large number of products capable of affording more or less a musk-like odorous substance, the musk-deer remains the only important commercial source of this substance.

PREPARATION OF MUSK FOR THE MARKET.—There are several ways of preparing the commercial musk, and the best method is to dry the pod by sunning and airing immediately after it is taken from the animal. The article, because of its powerful diffusion of odour, is usually packed in hermetically sealed vessels and wooden boxes lined with tin foil. The pods from the places of production are always packed in small skin bags singly, the pod inside the bag being covered with the animal's hair or similar stuff to keep its odour from diffusing as well as to protect it from the influence of the weather. For home consumption, Chinese traders occasionally pack the pods in silk-wrapped packages of two or three dozens each. Musk is collected from the hunters by a class of traders, who are also engaged in exporting medicinal herbs and other products of the highlands of the Szechwan Tibetan border, no Chinese merchant being engaged exclusively in the musk trade.

COMPOSITION AND PHYSICAL AND CHEMICAL CHARACTERS.—Musk when fresh is milky but later turns viscid and assumes a brownish red colour. It retains its odour for a long time and has a bitter aromatic taste. It is soluble in alcohol to the extent of about 10 per cent., in water to about 50 per cent. and also in ether and alkalies. It stains the paper yellow and gives a urinous smell on heating. It contains ammonia, olein, cholesterolin, fat, wax, gelatinous matter, albuminous substances and leaves an ash, which contains chiefly the chlorides of sodium, potassium and calcium. Musk yields by distillation with steam and subsequent purification, a small percentage of a viscid, colourless oil with a very powerful and agreeable odour of musk; this oil appears to be a ketone and has been termed muskone. Musk is remarkable for the power, permanency and stability of its odour, everything in its vicinity becoming affected by it and retaining the scent for a long time. It has been highly valued in perfumery, and though now not used alone is very largely employed to give permanence and strength to other odours. Perfumers use the scent for imparting an odour to soaps, powders, and in mixing liquid perfumery. Its fragrance is completely destroyed by contact with bodies such as camphor, valerian, bitter almonds, garlic, hydrocyanic acid and powdered ergot.

COMMERCIAL VARIETIES.—There are three kinds of musk to be distinguished in commerce. (1) The Russian musk. This variety possesses a poor fragrance and hence is not much esteemed.

(2) The American musk. It has got a very strong odour and fetches a much higher price than the first variety. In books on Hindu Medicine, Assam musk is described as 'Kamrup musk'. It is black in colour and has been considered to be the best variety available. (3) The Chinese musk is at present the most highly prized because of its freedom from any unpleasant smell suggestive of ammonia which is sometimes found in the inferior brands. The bulk of the musk exported from China comes from Tibet, the home of the musk-deer. It is bought up by the musk dealers of Tatsienlu, whence it is carried to Chungking. The variety of musk known in commerce as 'Tonkin musk' and chiefly used in perfumery comes from Western Szechuan and the eastern extensions of the Tibetan high plateau. Prior to the opening of steamer traffic on the Yangtse river in the past century, this variety of musk was exported *via* Tonkin to the south and it has retained the name Tonkin musk to this day. The chief market for this article in the interior is located in the city of Tatsienlu, close to the border of Tibet. In the province of Yunan, a certain quantity of musk is also obtained but it plays no role in commerce. A larger quantity comes to the market from the northern parts of Mongolia and Manchuria and from Eastern Siberia. This musk is known as 'cabardine' musk but is not used for first class products because of its penetrating unpleasant odour.

ADULTERATION OF MUSK.—On account of the great demand and the difficulty of obtaining it, musk is very frequently adulterated with inert substances such as dried blood, liver, etc. Vegetable products such as beans, wheat grains, barley grains, etc., are also mixed with the commercial article at the time of preparing. As musk quickly imparts its peculiar scent to other substances with which it comes in contact, detection of adulteration from smell becomes difficult. Several methods are in vogue amongst the Chinese and Tibetan dealers, which though not very scientific, are said to afford fairly good indications as to the genuineness of the article. Whenever any doubt exists, a few grains are extracted from the pod and placed in water. If these remain granular the musk is genuine, and if these melt the musk is false or adulterated. Another test is to place a few grains on a live piece of charcoal. If these melt and bubble, the musk is pure; if they at once harden and become cinder, it is adulterated. Genuine musk even when buried does not change its odour, while impure or adulterated musk gives out an entirely different smell. Adulterated musk can also be detected by touch. Genuine musk is soft and adulterated musk is stiff to the touch. An interesting popular test for musk has been reported from the Punjab. A thread is passed through asafoetida and then through the musk pod. If after this, the smell of asafoetida remains, the musk is not genuine.

ARTIFICIAL MUSK.—Since musk fetches a high price on the market, the unfortunate little animal—the musk deer—has been ruthlessly hunted for its valuable scent pod. Fear has been expressed by foreign naturalists for the early extinction of the animal if the present rate of destruction is allowed to go on without any restriction. It is estimated that at least twenty-two pods are required to make one 'catty' of musk. (1 catty=1½ lb.). Thus twenty-two male deer must be killed before the trade can bring one catty of musk pods to the market. As the musk sac is found on the abdomen of the buck only, and as there is no distinction in appearance between the male and the female deer when seen at a distance, many more animals of both sexes must be caught or killed, in order to secure a catty of musk pods. As the animals are hunted or trapped during the rutting season, they are getting exterminated and this fact, coupled with the increasing consumption in perfumery of the article in France, has led the chemists to look for some substitute of the natural article which can be prepared in the laboratory. Compounds having the odour of musk have been prepared synthetically but such substances have an entirely different chemical structure from the natural musk. These are, however, not poisonous and are largely substituted in the cheaper forms of perfumery for the expensive natural product. The musk substitutes at present known are trinitro-meta-tertiarybutyl-toluene and the corresponding compounds obtained from the homologues of toluene and the dinitro derivatives of the ketones which are formed by the interaction

of acyl chlorides on derivatives of toluene. Of these, *Trinitrobutyltoluol*, $\text{C}_6\text{HNO}_3\text{CH}_3\text{C}_4\text{H}_7$, has been considered to be the best. Its odour is very akin to the natural musk and is sold in perfumery under the name of artificial musk.

COMMERCIAL IMPORTANCE OF MUSK.—Musk is very largely used in India and in the Far East. Besides its medicinal use, musk is employed extensively in perfumeries. France is the largest buyer, taking about one-third of the exports. Some idea of the commercial importance of musk can be obtained from the fact that the annual value of the exports from China alone varies between £70,000 and £100,000, to say nothing of the large quantity which is retained in China itself, where it is used not only as a base for perfumes but as an ingredient of stimulating medicines. It is said that some six years ago the Lamas of Tsarung in South-East Tibet, owing to the relentless killing of the musk-deer, issued an edict prohibiting hunters from catching or killing the animal on very severe penalty. The edict is quoted as saying that any hunter caught killing musk-deer will have his hands cut off and nailed on the temple door. In spite of the Lamas' decree, with its terrible penalty, the quantity of musk brought out from the Tibetan border every year is fairly large.

A good deal of musk is also exported to the United Kingdom and other parts of the globe from India. According to Watt, total amount of musk exported from India during a period of ten years from 1878-1888 was 44,195 ounces worth about Rs. 11,17,579.

PHARMACOLOGICAL ACTION.—Little is known regarding the pharmacological action of this popular remedy. Most of the experiments recorded have been conducted with samples of musk obtained from the market which are likely to be, and as a matter of fact are, always highly adulterated. The tinctures of musk, both imported and indigenous, are not above suspicion. With a view to obviating any possible error in our observations, we obtained genuine samples of musk from a well-known practitioner of the indigenous system of medicine. These samples were collected from the original pods from musk deers killed in the territories of the Rana Saheb of Tharoch (Simla Hill States) and also from reliable dealers in Kashmir.

Solutions for pharmacological experiments were prepared in our laboratory by macerating the musk in a small quantity of alcohol and dissolving the whole in water, and keeping it for 24 hours. If the sample is moist, it can be dried in a vacuum desiccator over sulphuric acid when it loses nearly 15-20 per cent. of its weight of water. Musk is fairly soluble in water and by the above method of treatment, 70 to 75 per cent. of the material goes into solution, leaving behind debris of vegetable and cellular matter. If the solution is heated, a little more musk goes into solution but this was avoided as likely to lead to an escape of the volatile matter contained in the musk.

ACTION ON THE HIGHER CENTRES.—Musk and similar odourous substances have been used for a long time in the indigenous medicine in India as nerve sedatives in epilepsy, hysteria and convulsions in children. Indeed, in nearly all pharmacopoeias, ancient or modern, drugs which are characterised by a very powerful odour have been employed as nerve sedatives. It is very difficult, however, to estimate the real value of these therapeutic agents as their merits cannot be definitely substantiated by experimental proof in the laboratory. Macht and Tung (1921) devised a technique for studying quantitatively the sedative effects

of musk and other odorous substances on the central nervous system. A few drops of the solution of the aromatic drug were added to a wad of cotton in the neck of a funnel, under which rats were confined for about 15 minutes. The rats were then placed in the entrance to a maze and the time of traversal and the number of errors during their passage were noted. It was found that musk produced only a very slight depression of the higher centres, if any at all. In our experiments on animals in the laboratory, there was no evidence to show that musk has a sedative action at all. In doses of 2 gr. administered orally in several cases in the hospital, no sedative effect of the drug could be observed.

ACTION ON THE CIRCULATORY SYSTEM.—Intravenous injections of 10 to 20 mg. of the soluble portion of musk in 1 to 2 c.c. of water, injected into the femoral vein of cats under chloralose anaesthesia do not cause any change in the carotid blood pressure. In higher doses also, very little effect is observed. In isolated hearts of rabbits and kittens perfused by Langendorff's method, watery solutions of musk in concentrations varying from 1 in 1,000 to 1 in 200,000, do not bring about any alteration in the rate, rhythm and force of contraction of the heart. On the amphibian heart, injections of the aqueous solution of musk in the lymph sac or under the skin of frogs do not produce any noticeable change. In isolated heart of frogs also, perfused with frog Ringer solution, no stimulation of the organ is discernible on addition of weak or concentrated solutions of musk. Mudaliar, David and Reddy (1929) have recorded similar observations with tincture of musk obtained from Messrs. Southall Bros. and Barclay Ltd., Birmingham.

ACTION ON THE CELLULAR ELEMENTS OF THE BLOOD.—According to Mudaliar, David and Reddy (1929) musk has a well-marked effect on the cellular elements of the blood. The total number of leucocytes are said to be increased after oral administration. This effect, according to these workers, is particularly marked in patients who have leucopenia, the total leucocytic count being doubled in some patients after musk, while comparatively little change is produced in normal individuals or in those with leucocytosis. They administered 10 to 20 minims of tincture of musk in an ounce of water and found that within $\frac{1}{2}$ to 1 hour after administration the total leucocyte count showed a definite increase. In order to confirm these observations, the drug was administered in the wards of the Carmichael Hospital for Tropical Diseases, to healthy individuals as well as in a group of six patients suffering from kala-azar with a marked leucopenia. Powdered musk in doses of 1 gr. was administered to the subjects $2\frac{1}{2}$ hours after food daily for seven consecutive days and regular records were kept of the blood pressure, the rate, volume and tension of the radial pulse; the total erythrocytic and leucocytic counts were done at the same time. As the counts done soon after musk is given are likely to be fallacious on account of psychic and gastric reflexes set up by the drug, we made observations at least two to three hours after the dose was given. The blood counts were made before and after the administration of musk and again at the end of a period of seven days; even at this date no appreciable changes were observed in the count. The blood pressure, pulse rate, tension,

etc., showed no appreciable changes. In healthy individuals (laboratory assistants) no change in the pulse rate, blood pressure and blood counts could be observed after two grain doses of musk. The subjects, however, stated that they felt a general sensation of well-being in the stomach and that the drug seemed to produce an effect resembling in many ways a dose of carminative mixture which was administered to them with a view to comparing the effects. The results obtained in case of the kala-azar patients were similar to those observed in case of the healthy individuals and no appreciable rise in the leucocyte counts could be observed.

ACTION ON THE RESPIRATORY SYSTEM.—In animals under urethane anaesthesia, injections of 10-20 mg. of soluble portions of musk in 1 to 2 c.c. of water do not produce any marked change in the intratracheal pressure tracings. When, however, a cotton-wool pledget soaked in musk solution is brought in close proximity to the nose of such an animal, a distinct but very transient stimulation of respiration is noticed. This transient stimulation is also observed when a minute quantity of aqueous solution of musk is gently sprayed by means of a small syringe into the nasal mucous membrane of the anaesthetised animal. The time taken for the stimulation in the latter case, however, is longer than when the musk is brought in touch with the nose. This is probably due to the fact that odourous substances must be in a volatile state to produce typical odour responses through the olfactory nerve-endings. Musk solutions when sprayed directly into the tracheal mucous membrane through an opening in the tracheal cannula, however, fail to produce the stimulation noticed in case of the direct application of the drug to the nasal mucous membrane. These experiments show that musk has got no special action on the respiratory system. Whatever slight stimulation of respiration is observed is probably entirely reflex brought about by the stimulation of the olfactory nerves of the nasal mucous membrane which carry the impulses *via* the olfactory bulbs and tracts to the higher centres in the hippocampal gyrus. From these areas, the respiratory centre in the medulla is probably stimulated through the conducting fibres passing from the brain to the cord. This seems likely as musk is one of the most powerful of the odourous substances known. Valentin (1903) has estimated that a total of 0.02 mg. (0.00,000,009 mg. per litre) can be distinctly smelt by human beings. From this, the strong sensory stimulation which is produced may be easily imagined.

USES OF MUSK IN MEDICINE.—Musk has been used by the Hindu physicians for a long time and forms the constituent of a number of preparations. In the 'Bhavaprakasa' three varieties are described, namely Kamrupa, Nepala, Kashmira. The first is described as black and superior to others, and probably consists of China and Tibet musk imported *via* Kamrup. That from Nepal described as being of bluish black in colour, is of intermediate quality, while the Kashmiree musk is inferior to all. The Hindu physicians regard the drug as a cardiac and general stimulant, aphrodisiac, and employ it as an antispasmodic and anodyne in low fevers, chronic cough, general debility and impotence. Its fame as a cardiac stimulant is so great that it is almost the last resort when everything else has

failed to support the heart. As a cardiac stimulant, it is prescribed sometimes alone and sometimes in combination with 'makaradhwaja' (insoluble sulphide of mercury) and *Sida cordifolia* (Berela or Bala). It is said to stimulate the brain, the respiratory and vasomotor centres in the medulla, spinal cord and peripheral nerves. It increases the arterial tension and is said to stimulate the uro-genital organs. The elimination is by the urine, sweat and milk. In low fevers with prostration, anaemia and general debility as a result of chronic ailments it is particularly valued. Its use as an aphrodisiac in sexual impotence has been very much in vogue. Tamil physicians in South India prescribe the remedy in children in cases of convulsions combined with opium; it has also a reputation of curing dyspepsia and colitis.

Musk was introduced in the Western medicine probably at the latter part of the sixteenth century. Since then, it has been prescribed as a stimulant in many ailments, *e.g.*, typhoid fever, typhus, gout, in lockjaw or tetanus, hydrophobia, epileptiform and hysterical attacks, chorea, whooping cough, hiccough, asthma, colic, etc. Crookshank (1905) spoke well of the drug in acute specific infections resulting in toxic involvement of the central nervous system. He used 5 gr. of the powdered musk every 2 hours with satisfactory results. In convulsions of children, where no definite causative factor can be determined, musk has been used with promising results in combination with chloral hydras. Still (1906) recommended a rectal injection of chloral hydras (gr. 5 to 10 according to age) and tincture of musk (10 drops to 30 drops). It has also been used as a cardiac stimulant in cases of failing circulation, and palpitation of the heart under the belief that it raises the blood pressure and improves the character and volume of the pulse. The belief in the efficacy of the drug, however, is gradually changing. Musk was once official in the British Pharmacopoeia, but has since been removed. It was official in U.S.P. IX, but has been deleted from U.S.P. X.

Ticture of musk is still very largely used by medical men in India in doses of 10 to 30 minims as a cardiac stimulant, in depressed conditions of the nervous system and as an aphrodisiac. Our own work, both experimental and clinical does not bear out the cardiac- tonic and leucocyte-raising properties attributed to musk. Whatever stimulant effect it might have is probably reflex from the olfactory nerves on account of its strong smell and from the stomach on account of its slightly irritant effect on the mucous membrane. We have already observed that patients who had received a dose of musk have a feeling of warmth and well being in the stomach and this may reflexly produce slight stimulation of the heart and respiration. There appears to be no foundation for belief in its efficacy in epilepsy, chorea and in convulsions of children. In hysteriform attacks it probably acts in the very much the same way as strong smelling substances such as asafoetida, valerian, etc. In whooping cough and colic, its action probably resembles the drugs of the essential-oil group. From our observations, we have come to the conclusion that the importance of musk in the indigenous medicine in India has been very much over-rated and that it has not got any marked physiological or therapeutic properties.

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MYLABRIS (Meloideæ)

Mylabris cichorii Linn., M. pustulata Thunb. and M. macilenta

INDIAN BLISTERING BEETLE

VERN.—Hind.—*Teleni-makkhi*; Tam.—*Pinsttarini*.

Cantharidin is well-known in Western medicine and is widely employed in the form of plasters for its counter-irritant, rubefacient and vesicant properties. It is contained in more than a dozen medicinal preparations, most of which are meant for external application. Owing to its irritating properties, internal administration is not common but in small doses it has been often used, alone or in combination, in such diseases as lupus, cystitis, incontinence of urine, spermatorrhoea, etc. Its use as an ingredient of hair lotions, hair oils and several other cosmetic preparations like pomades, etc., appears to be getting more and more popular every year. It is reported to stimulate the growth of hair. Cantharidin is a colourless crystalline lactone derived originally from the dried Spanish beetles known as *Cantharis vesicatoria* Latreille. These beetles are from 18 to 25 mm. long and about 6 mm. broad, smooth and of a shining green or bronze green colour. They are widely distributed over Southern Europe, living gregariously in olive trees, ash, white poplar, privet and elder trees. The ordinary practice is to collect the beetles on cloth spread out below the plants to which the insects are thrown down by shaking the plants. It is better to capture them before sunrise while they are unable to use their wings. They are then killed by means of ammonia, vinegar, sulphur dioxide, or by heat, and cantharidin is extracted from these beetles after they are thoroughly dried in the sun. Most of the cantharidin exists in the free state and only a very minute quantity is in combination as salts.

Cantharides contain 0.5 to 0.9 per cent. of a colourless crystalline compound, cantharidin, which is the inner anhydride of a dibasic acid, cantharidic acid. The insects contain both cantharidin and salts of cantharidic acid. Cantharidin on treatment with alkalis forms soluble cantharidates, but solutions of the latter when acidified yield a precipitate of cantharidin. The insects also contain about 12 per cent. of fat which is associated with the cantharidin and cantharidates in the softer parts of the body. The preparation of cantharidin involves the liberation of cantharidin present in the form of salts by means of acid and extraction of both cantharidin and fat by means of a solvent such as ethyl acetate. The solvent is recovered and impure cantharidin crystallises out. The fat may then be removed

with light petroleum (in which cantharidin is only slightly soluble), and the crude cantharidin recrystallised from hot alcohol.

Several species of blistering beetles are found in different parts of the world. In China and in the Far East, *Mylabris* beetles are available in considerable quantities. These beetles differ from the Spanish beetles in being larger, broader and in having much darker upper wing-cases, but they belong to the same large order of insects known as Coleoptera. *Mylabris sidac* (*M. phalcrata*) and *M. cichorii* are the two species available in China and Far East and their collection for purposes of export to other countries is a regular business there and is said to be quite remunerative. In India, *M. cichorii* (Teleni makhi), *M. pustulata* and *M. macilenta* are found in enormous quantities, and these are recognised in the Indian Pharmacopoeia. *M. pustulata* has been collected in fairly large quantities in fields of cereals and vegetables in the neighbourhood of Bangalore by Iyer and Guha (1931). *M. cichorii* occurs abundantly during the rainy season in certain parts of Northern India and Kashmir, but no systematic attempt has thus far been made to collect them and utilise them for medicinal purposes. At present, the dried insects or cantharidin preparations are imported from other countries at a high price in spite of the fact that an ample supply of blister beetles is available in India. Very little has been done towards systematic collection of the beetles and the main difficulty of the pharmaceutical chemists who wish to manufacture cantharidin lies in getting a regular supply of the indigenous beetles. That cantharidin could be successfully extracted in India was convincingly shown as early as 1907 by Puran Singh. A firm of manufacturing chemists in Calcutta actually prepared the drug and offered it for sale to the public but this has been discontinued on account of foreign competition. Iyer and Guha (1931) have shown that the Indian beetle, *M. pustulata* yields about 2.9 per cent. cantharidin as compared to the maximum yield of 1.9 per cent. from Chinese beetles. The yield from the Spanish beetles is even less (1.2 per cent. approx.). *M. cichorii* yields 1.25 per cent. of cantharidin. There is also present about 12 per cent. of fixed oil and a volatile principle on which the fetid odour of the fly depends. As the cost of laboratory production, representing labour of collection and value of materials, without deduction for recovery of ethyl acetate (obtained as a by-product), amounts roughly to 8-12 annas per gm., the production of cantharidin from the indigenous sources is bound to succeed at the present market price of imported cantharidin at over Rs. 2 per gm. There is also an indirect benefit to be derived. The collection of these herbivorous beetles for cantharidin extraction would be of great benefit to the agriculturists by removing a serious menace to crops and gardens.

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SNAKE VENOM

VERN.—Sans.—*Sarpavisha*, *Garala*.

The use of snake venom in the Hindu medicine is of comparatively recent origin as references to it are chiefly met with in such modern works as 'Ratnavali', 'Sarkaumudi', etc. Although the venoms of other snakes are mentioned, the venoms of the Indian cobra and Indian viper have been chiefly used. The Indian cobra—*Naia naia* vel *tripudians*—varies from 150 to 190 cm. in length and has a variable colour but is usually black. The head is generally golden yellow in colour, spotted with yellowish white marks above and pure white beneath. This species is distributed throughout the whole of Southern Asia from the South of the Caspian Sea to South of China, India and the Malay Archipelago. Several varieties of it are met with in India, *Naja tripudians* and *Naja bungarus* being the two formidable varieties.

The Indian Vipers: Two poisonous snakes belonging to this group commonly occur in India. (1) *Daboia russelli* vel *elegans* is about 200 cm. in length and has a beautiful grayish yellow or light brown colour. It may be distinguished by three rows of brown black spots on the body, the outer two rows consisting of spots ringed with white edges. It is found all over the plains of India particularly in Ceylon, Siam, Burma, Rajputana and Bengal. It has been met with in Kulu and Kashmir valleys at an altitude of 5,000 to 6,000 ft. though generally it is an inhabitant of plains and valleys up to 2,000 to 3,000 ft. The reptile is quiet in habit and attacks man only in self-defence or when it is provoked to attack. It produces a terrible hissing sound when in readiness to attack.

(2) *Echis carinata* is another viper which is frequently met with in India. It is found in the North-Western Frontier Province, Baluchistan, the Punjab, Sind, Rajputana, Central India and some parts of Madras and Ceylon. It is 40 to 50 cm. in length and has a brown or brownish-grey colour. The back is marked with two rows of whitish longitudinal zig-zag lines stretching over the whole body. The upper surface of the head exhibits a yellowish rhomboidal spot looking like a cross. The body is covered with imbricated and keeled scales which make a peculiar rustling sound when the reptile moves along.

The poisonous glands of the snakes are situated at the back portion of the upper jaw. The ducts are connected with the fangs. The poison is squeezed out when the snake closes the jaws tightly in the act of biting or swallowing. The venom is only a digestive secretion. Every time the snake swallows the food the poison is swallowed with it and helps in digestion, particularly of proteins.

PHYSICAL AND CHEMICAL CHARACTERISTICS.—The venom is obtained by forcing open the jaws and squeezing the glands into a sterile petri dish or by making the reptile bite a petri dish with a rubber membrane stretched over it. When fresh the venom is a clear transparent fluid. It has a faintly acid reaction and its consistence varies from that of water to that of the white of an egg. When dried under a bell jar in the sun or over concentrated sulphuric acid, it loses 50 to 70 per cent. of water and is converted into a yellowish granular mass which

can be powdered. The dried venom retains all the properties of the fresh venom. When kept in a liquid state it becomes alkaline with the deposit of a feather-like substance, but when kept in hermetically sealed ampoules in a cool dark place, it retains its potency for a long period.

The venom is composed of variable amounts of proteins, albumoses, pigments, mucus, epithelial debris, fatty matters, salts like chlorides and phosphates of calcium, ammonia and magnesium, analogous to the constituents of normal saliva. The chemical nature of the venom, however, is very variable and uncertain. It resembles protein in its reactions since it can be precipitated with alcohol, tannins, etc., and does not diffuse through the dialysing membrane. Armand Gautier (1883) believed that venom contains an alkaloid, which could be separated out by pulverising the venom with carbonate of soda and systematically extracting the mixture with alcoholic ether at 50°C., but other workers have not succeeded in separating any alkaloid. Mitchel and Reichert (1884) showed that the cobra venom consists of 98 per cent. of albumin and only 2 per cent. of globulin. Viper venom on the other hand consists of nearly 25 per cent. globulins.

According to Martin and Smith (1892) the cobra venom albumoses can be fractionated into hetero-albumoses, proto-albumoses and deuterio-albumoses, but the albumins contained in it are devoid of all toxic power. Many chemical substances like 1 per cent. solution of potassium permanganate, gold chloride, chloride of lime and even hypochloride of calcium (1 in 12), chromic acid, bromine water, 1 per cent. trichloride of iodine modify or delay the action of venom. There has been much discussion regarding the nature of the toxic principle in the different venoms (1902). According to Faust (1910-11) the chief toxic substances in the cobra and rattle snake venoms are some non-nitrogenous principles. These are not glycosides but otherwise resemble saponins in their physical, chemical and pharmacological properties. They are responsible for its action on the central nervous system. Cobra venom can stand the temperature of 100°C. for a short time without losing all its activity. The toxicity of the cobra venom is not modified by filtration through a porcelain candle, while that of viper venom is altered considerably. In this way the non-diffusible albuminoid coagulable at 82°C. and diffusible non-coagulable albumose can be separated. The former which produces haemorrhages has been called *haemorrhagin* and the latter which acts on the nerve cells of the respiratory centre has been called *neurotoxin*. Most of the colubrin and viperin snake poisons contain the haemolytic principle. In general it may be said that the first effect of the venom is to produce agglutination of the erythrocytes followed by their solution after a variable interval, which depends on the kind of snake and the potency of the venom. The agglutinating power of the venom is destroyed at a temperature between 75 to 80°C. maintained for 30 minutes. Different venoms differ in their haemolytic power. Cobra venom is the most active in this respect and then follow the venoms of water moccasin, copper head, rattle-snake in the order named. Variations in susceptibility to this reaction are present in different animals. Dog's blood is most quickly and easily haemolysed in high dilutions, while the ox's corpuscles are least susceptible. The intermediate animals are the sheep, guineapig, pig and rabbit, etc. This variation, it is suggested, is due to variation in the lecithin content of the blood. Ox's blood can be haemolysed even in very high dilutions of the venom in the presence of lecithin. The haemolytic power of the venom is only slightly effected if the venom is exposed to 100°C. for 10 to 15 minutes. Acton and Knowles (1913-14) have shown that most of the venoms consist of (a) *haemorrhagin* which has the property of destroying the endothelial cells lining the finer blood vessels and of giving rise to ecchymosis and extravasation of blood, (b) a *cytolysin* which dissolves both the red and white blood corpuscles, and (c) a fibrin ferment which causes an intra- and extra-vascular clotting leading to pulmonary embolism and death from asphyxia and (d) a *neurotoxin* which acts on the central nervous system as well as on the nerve endings.

The venom is also said to possess the power of destroying the bactericidal properties of the normal blood sera. Welch and Ewing (1894) explained that the rapid putrefaction which

sets in in the animals after poisoning with cobra venom is due to this property. This reduction of the bactericidal power of the normal sera is due to the fixation of the serum complement by the venom. The venom has no action on the intermediary body of the serum. Calmette's antivenin has the restraining action upon the venom haemolysis and venom bacteriolysis.

PHARMACOLOGICAL ACTION OF COBRA VENOM.—It was believed that the action of the cobra and viper venoms was the same and that the divergence of symptoms noticed in the two cases were only due to the difference in the degree of toxicity. It was suggested later that these two venoms have entirely different seats of action. Epstein (1930) studied the action of the South African cobra, *Naia flava* (*Naia vivea*) and found that it produced death by respiratory failure. The venom also has a direct action on the involuntary muscles, contraction being followed by relaxation. Chopra and Iswarial (1931) have made a pharmacological study of the action of the venom of the Indian cobra, *Naia naia* vel *tripudians*. The M.L.D. of the venom varies with the species of the animals; cats and rats are less susceptible; dogs, rabbits and man are more easily affected. When given intravenously the venom produces an immediate effect, the animal dying within a few minutes of respiratory failure provided a large enough dose is given. The absorption is slower when the venom is given by the subcutaneous and intramuscular routes, death taking place in 4 to 24 hours. The venom is not absorbed at all from the gastro-intestinal tract or other mucous membranes. The venom has no effect on the activity of salivary, gastric and pancreatic secretions of man *in vitro*. It slightly increases the tone of the musculature of the gastro-intestinal tract in cats and rabbits.

Injections of sub-lethal doses of the venom produce a small but persistent rise of blood pressure in experimental animals. This rise is not due to any stimulant action on the accelerator mechanism of the heart or on the myocardium. None of the concentrations of the venom, however high or low, produce definite stimulation of the heart especially when it is failing. Very large doses appear to act directly on the heart producing a marked depression and stoppage. The rise of blood pressure appears to be associated with the stimulation of the vaso-motor centre in the medulla as it is absent in decerebrated animals. The fall of blood pressure produced by large doses has been shown to be due to paralysis of the vaso-motor centre. The main action of the venom in lethal and sub-lethal doses on the animal is on the respiratory centre, the effect being one of initial stimulation and final paralysis. The venom appears to have no effect on the motor end-plates in the diaphragm or other respiratory muscles. Observations on animals show that the venom produces initial stimulation of the higher parts of the brain followed by paralysis. It has been shown by Chopra and Chowhan (1931) that contrary to the general belief the cobra venom has a toxic action on lower organisms such as the *Paramecium caudatum*.

PHARMACOLOGICAL ACTION OF DABOIA VENOM.—The venom of Russell's viper produces local abscesses, cellulitis or necrosis of the tissue at the site of the bite. This marked local action is due to large quantities (25 per cent.) of the globulins. The systemic effects are haemorrhagic effusions in the splanchnic area and ascending paralysis of the central nervous system. The toxicity of dabobia venom is reduced to one-third when it is mixed with formalin and incubated for some time. It digests fibrin on account of the presence of fibrin ferment, trypsin. Lamb found that viper loses its coagulation power when it is heated to 75 to 80°C. The neurotoxic coagulant substances present in it can be precipitated out with alcohol.

There has been a good deal of divergence of opinion regarding the cause of death with viper venom. Cunningham (1894) reported that death in the animals bitten by Indian dabobia is due to its direct action on the central nervous system. Martin (1897) believed the cause of death to be intravascular clotting. Later, Lamb and Hanna (1903) working on the Indian dabobia also showed that the death was due to extensive intravascular clotting. The minimum lethal dose for the rabbit is found to be 0.26 mgm. per kilogram intravenously. Fowls bitten by this viper die within 30 seconds, dogs in 7 minutes and cats in about an hour; the horses die in about 11½ hours. Acton and Knowles (1914) found the minimum

lethal dose to be 0.5 to 2.5 mgm. per 100 gm. of the wild rat, death occurring in 8 to 14 hours. In rabbits and guineapigs when lethal doses were given the action was not so rapid as in the case with cobra venom. The action appears to be mainly local, the venom being fixed locally on account of the clotting action of the blood. In case of wild rats 8 to 9 mg. intravenously was fatal in 2 to 4 hours in animals weighing 700 gm. The animal at first showed restlessness, breathlessness and then became dyspneic, asphyxial convulsions and paralysis of the hind limbs following. The death occurs owing to respiratory failure, the heart continuing to beat for some time after the respiration stops. Frogs are least susceptible. Chopra and Chowhan (1932) have shown that the viper venom unlike cobra venom has little or no action on the protozoal organisms. In experimental animals the blood pressure falls with a rise in the volumes of the spleen and intestines and with engorgement of the splanchnic blood vessels; the heart dilates at first and then stops in diastole. The effect of the venom appears to be like that of histamine. Saline infusions and adrenaline injections revive the animal by increasing the blood volume and constricting the systemic blood vessels.

The pharmacological action of the venom of *Echis carinata* is similar to that of Indian daboia. It is marked by intense local inflammation, severe pain and gangrene at the site of the bite. Haemorrhages and sero-sanguinous effusions are found in all the serous cavities—pleura, pericardium and peritoneum. The blood pressure shows an enormous fall, the reflexes are reduced and finally the heart becomes very feeble and stops in diastole.

THERAPEUTIC USES OF THE VENOMS.—Snake venom forms the constituent of a number of preparations used by the Hindu physicians. Pills containing cobra venom are used in collapse, chorea, etc. With fresh juice of sugarcane, it is given in the treatment of ascites. It is said to be an irritant to the bowel, has a purgative action and is used as a hepatic stimulant. Certain classes of people in India take small doses of snake venom habitually by the mouth with the idea that it protects them from the effects of poisons and diseases. Snake venoms have been recently used in the Western medicine in the treatment of epilepsy, chorea, black-water fever, haemophilia, etc. It is said that the pathological effect of any given venom on man varies with the dose injected, and that though large doses may be lethal, small doses may produce beneficial physiological effects. In the treatment of epilepsy, the venom is given in doses of 1/200 gr. by hypodermic injections, three to five such injections being given at eight day's interval, afterwards two more injections of 1/75 gr. at 14 days' interval. If the symptoms do not disappear another dose 1/25 gr. is recommended. The dose and the interval of the administration had to be varied according to the age of the patient and the nature of the injury. Fitzsimons (1929) pointed out that this method of treatment is not free from danger unless the venom is properly prepared by skilled hands.

Spangler (1925) used for non-specific therapy intramuscular injections of the protein of the venom of the rattle snake (crotalin) which contains a peptone and a globulin. He took the degree of eosinophilia produced as a guide to dosage and frequency of administration of the proteins. Usually the highest rise in the percentage of eosinophils following venom protein injections in doses of 1/400 to 1/50 gr. occurs by the second or third day. In from five to seven days after injection, the eosinophils will usually have dropped to 4 per cent. or less, and the patient may be given another injection. The strength of the dose is not increased if a given strength produces an increase of 8 to 10 per cent. eosinophils

by the second or third day after an injection. By continuing the injections the rise of the eosinophils gradually becomes less, and finally does not exceed normal limits. The patient is then non-specifically desensitized.

Cobra venom is also said to afford a means of diagnosing cancer—Formachidis test. This test depends upon the activation by cobra venom of the haemolytic action of serum in the deviation of complement test, and the assertion is that the test occurs only with the serum of persons suffering from malignant disease. Injections of venom of *Viper aspis* are also said to protect animals against fixed virus of rabies.

The experimental work by the author and his co-workers has shown that cobra venom is not absorbed from the gastro-intestinal tract. It is therefore, difficult to see how the venom given by the mouth can produce the effects it is claimed to produce by the practitioners of indigenous medicine. Besides its irritant effect on the gut, it does not appear to produce any other marked action. As regards the stimulant action of the venom on the circulatory system, it is clear from the experimental data obtained that cobra venom has no direct effect either on the myocardium or on the accelerator nerves in the heart. It undoubtedly produces a small but persistent rise of blood pressure probably on account of its stimulant action on the vasomotor centre in the medulla when it is given intravenously. This effect would not be produced when the drug is given by the mouth. The margin between the stimulant and the paralytic dose of the venom on the medullary centres is too small to warrant the use of the drug by injection. There also appears to be no rational basis for its use in the treatment of epilepsy, chorea, haemophilia, etc., for which it is given by injection by the practitioners of the Western medicine.

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PART IV

INDIAN MATERIA MEDICA

One of the greatest difficulties which confront the worker engaged in research on the Indian indigenous drugs is to get authentic information regarding the medicinal plants from which these drugs are obtained in India. The materia medica of the indigenous systems is derived mainly from vegetable sources and is extensive and heterogeneous. In different parts of this vast country many different plants are attributed medicinal properties. Unfortunately the information regarding these is very scattered among the large number of old books and periodicals which are not quite accessible. Very little original research was done during the first quarter of this century and many of the old publications on the subject contain data derived from the old literature, which sometimes are not accurate. The authors receive letters from all parts of India and abroad for the supply of information regarding the medicinal properties and uses of flowers, roots, barks, leaves, etc., of plants reputed to have some medicinal property. In spite of the facilities at their disposal, the difficulty of obtaining the authentic information from the scattered literature is very great. The necessity for a work in which all the known data could be concisely put so that it could serve as a guide to all those interested in this subject has, therefore, been felt. With this object in view, the following lists of commonly used medicinal plants and other materia medica used in the indigenous medicine, have been compiled after consulting eminent practitioners and well-known firms of manufactures of Ayurvedic and Tibbi medicine. For the sake of convenience this whole compilation has been divided into four sections, each of which again has been sub-divided into several chapters. It is hoped that the data contained therein will be useful to those interested in the Indian indigenous drugs and will facilitate and encourage research in the subject.

Of the three chapters under the first section, Chapter A deals entirely with drugs of vegetable origin, forming by far the largest majority of the remedies used in the indigenous medicine. To save space, the botanical descriptions of plants have been omitted. The list has been alphabetically arranged so that it will be easy for the readers to find the particular drug on which he wants information. Abbreviations have been used to save space; list of abbreviations used is given for ready reference. The scientific names of the plants and the names of the botanists responsible for the nomenclature are included. Mere mention of the name of the plant without the name of the botanist, may give rise to confusion. The families to which these plants belong come next. Important vernacular names commonly used in the different States of India have been given and a separate index has been provided at the end. This will enable the reader to trace the plant if he knows one of the common vernacular names. For want of space it has not been possible

to include all the vernacular names. The conditions in which the particular plant is used are briefly given. A special feature which will not fail to attract attention, is the description of the active principles of the plants as far as they have been worked out. The references to the important published literature concerning different plants from Indian, European and American sources up to 1954 have been included. It is hoped that this will greatly enhance the utility of the book to the research workers. For more details the reader is referred to *Glossary of Indian Medicinal Plants* by Chopra, R. N., Nayar, S. L. and Chopra, I. C. published by Council of Scientific & Industrial Research, New Delhi, 1956.

Chapter B describes the inorganic substances used in the indigenous medicine. It would be observed that most of these products are crude salts or mineral ores as they occur in nature. This shows that the art of adopting the metals and metallic compounds for medicinal purposes was not highly developed.

Chapter C deals with drugs of animal origin in very much the same way as the first. From the large and varied collection of animal substances employed it would appear that the ancient physicians had some knowledge of the properties of the gland and tissue products that are in use today.

For the convenience of the readers we have given names of important plants containing active principles in an alphabetic order. Section II has been divided into six chapters and deals with plants alleged to have poisonous properties ; those liable to produce dermatitis, reputed abortifacient and emmenagogue ; insecticidal, insect repellent and piscicidal plants. Plants containing poisonous principles, such as hydrocyanic acid and cyanogenetic glycosides, arsenic, barium, oxallic acid, etc. have also been separately listed.

Section III is divided into six chapters and deals with plants alleged to have antiseptic, anti-tubercular and anti-dysenteric properties. Drugs considered useful in the treatment of cholera and prolonged fevers have also been enumerated. The plant remedies reputed to be effective in the indigenous medicine in the treatment of snake-bite and against scorpion-sting have been mentioned.

Section IV deals with miscellaneous group of plants and has been divided into four chapters. The first deals with essential oil bearing plants and their medicinal and other uses ; the second briefly describes the Lichens and their medicinal properties ; in the third Ferns of India used medicinally are briefly dealt with and in the fourth both edible and poisonous mushrooms or fleshy fungi are referred to.

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- C.R. Acad. Sci., Paris*—Compte rendu hebdomadaire des seances de l'Academie des sciences. Paris.
- C.R. Acad. Sci. U.R.S.S.*—Compte rendu de l'Academie des Sciences de l'U.R.S.S.
- C.R. Soc. Biol., Paris*—Compte rendu hebdomadaire des seances, et memoires de la Societe de biologie. Paris.
- Curr. Sci.*—Current Science. Bangalore.
- Dansk Tidsskr. Farm.*—Dansk Tidsskrift for Farmaci. Kjobenhavn.
- Dokl. obsch. Sobr. Ak. Nauk S.S.S.R.*—Doklady na obščem Sobranii (Akad. Nauk U.S.S.R.).
- Drug Cosmet. Ind.*—Drug and Cosmetic Industry. New York.
- Drugg. Circ.*—Druggist's Circular. New York.
- Dtsch. ApothZtg.*—Deutsche Apothekerzeitung. Berlin.
- Dtsch. Heilpfl.*—Deutsche Heilpflanze. Stollberg i.F.
- Dtsch. ParfumZtg.*—Deutsche Parfumeriezeitung. Berlin.
- E. Afr. agric. J.*—East African Agricultural Journal. Nairobi.
- Econ. Bot.*—Economic Botany. Lancaster, Pa.
- Experientia*—Experientia. Basel.
- Exp. Med. Surg.*—Experimental Medicine and Surgery. New York.
- Farmacoter. act.*—Farmacoterapia actual. Madrid.
- Farmakol. i Toksikol.*—Farmakologiya i Toksikologiya. Moscow.
- Farmatsiya*—Farmatsiya. Moscow.
- Farmatsiya i Farmakol.*—Farmatsiya i Farmakologiya.
- Farm. Zh.*—Farmatsevtichnie Zhurnal. Kharkiv.
- Fitoterapia*—Fitoterapia. Rivista trimestrale di studi e applicazioni di piante medicinali.
- Fmr's Bull. U.S. Dep. Agric.*—Farmers' Bulletin. U.S. Department of Agriculture. Washington.
- Folia med. Napoli*—Folia medica. Napoli.
- Folia Pharm. jap.*—Folia pharmacologica japonica. Kyoto.
- Food*—Food, preserving, packing, marketing. London.
- For. Bull. Dehra Dun*—Forest Bulletin. Forest Research Institute, Dehra Dun.
- For. Res. India*—Forest Research in India (and Burma). Delhi.

- Gambrinus*—Gambrinus. Brauer-u. Hopf-
enzeitung. Wien.
- Gazz. chim. ital.*—Gazetta chimica italiana.
Roma.
- Helv. chim. acta*—Helvetica chimica acta.
Basel, Genf.
- Hlth Bull.*—Health Bulletin, Delhi.
- Hoppe-Scyl. Z.*—Hoppe-Seyler's Zeitschrift
für physiologische Chemie. Strassburg.
- Indian Fmg.*—Indian Farming. Delhi.
- Indian Food Packer*—Indian Food Packer.
Delhi.
- Indian For.*—Indian Forester. Dehra Dun.
- Indian For. Bull.*—Indian Forest Bulletin.
Dehra Dun.
- Indian For. Leaf.*—Indian Forest Leaflet.
Dehra Dun.
- Indian For. Rec.*—Indian Forest Records.
Dehra Dun.
- Indian J. agric. Sci.*—Indian Journal of
Agricultural Science. Delhi.
- Indian J. Ent.*—Indian Journal of Entomology.
New Delhi.
- Indian J. med. Res.*—Indian Journal of
Medical Research. Calcutta.
- Indian J. Pharm.*—Indian Journal of Pharmacy.
Bombay.
- Indian J. vet. Sci.*—Indian Journal of
Veterinary Science and Animal Husbandry.
Delhi.
- Indian med. Gaz.*—Indian Medical Gazette.
Calcutta.
- Indian med. Rec.*—Indian Medical Record.
Calcutta.
- Indian Soap J.*—Indian Soap Journal.
Calcutta.
- Indian Tr. J.*—Indian Trade Journal.
Calcutta.
- Industr. Engng. Chem.*—Industrial and
Engineering Chemistry. Easton, Pa.
Industrial Edition.
- Industr. Engng Chem. (News)*—Industrial
and Engineering Chemistry. Easton, Pa.
News Edition.
- Ingen. Ned. Ind.*—Ingenieur in Nederland-
sch-Indie.
- J. agric. chem. Soc. Japan*—Journal of the
Agricultural Chemical Society of Japan.
Tokyo.
- J. agric. Res.*—Journal of Agricultural Research.
Washington.
- J. Amer. chem. Soc.*—Journal of the American
Chemical Society. Easton, Pa.
- J. Amer. pharm. Ass.*—Journal of the
American Pharmaceutical Association.
Columbus.
- J. Amer. Soc. Agron.*—Journal of the
American Society of Agronomy
Washington.
- J. Amer. vet. med. Ass.*—Journal of the
American Veterinary Medical Association.
Ithaca, N.Y.
- J. Annamalai Univ.*—Journal of the Annamalai
University. Annamalaiagar.
- Jap. J. med. Sci.*—Japanese Journal of
Medical Sciences, Abstracts. Tokyo.
- J. Asiat. Soc. Beng.*—Journal and Proceedings
of the Asiatic Society of Bengal
Calcutta.
- J. Ass. off. agric. Chem. Wash*—Journal of
the Association of Official Agricultural
Chemists. Washington.
- J. Biochem. Tokyo.*—Journal of Biochemistry.
Tokyo.
- J. biol. Chem.*—Journal of Biological
Chemistry. Baltimore.
- J. Bombay nat. Hist. Soc.*—Journal of the
Bombay Natural History Society
Bombay.
- Jb. wiss. Bot.*—Jahrbuch für wissenschaftliche
Botanik. Berlin.
- J. chem. Engng China*—Journal of Chemical
Engineering, China. Tientsin.
- J. Chin. chem. Soc.*—Journal of the Chinese
Chemical Society. Peiping.
- J. Coll. Agric. Tokyo*—Journal of the
College of Agriculture, Imp. University
of Tokyo.
- J. comp. Path.*—Journal of Comparative
Pathology and Therapeutics. Edinburgh,
London.
- J. C. S.*—Journal of the Chemical Society.
London.
- J. Elisha Mitchell sci. Soc.*—Journal of the
Elisha Mitchell Scientific Society. Chapel
Hill, N.C.
- J. exp. Med.*—Journal of Experimental
Medicine. New York.
- J. For.*—Journal of Forestry. Washington.
- J. gen. Chem., Moscow*—Journal of General
Chemistry. Moscow.
- J. Indian chem. Soc.*—Journal of the
Indian Chemical Society. Calcutta.

- J. Indian chem. Soc. industr. Edn.*—Journal of the Indian Chemical Society. Industrial and News Edition. Calcutta.
- J. Indian Inst. Sci.*—Journal of the Indian Institute of Science. Bangalore.
- J. Indian med. Ass.*—Journal of the Indian Medical Association. Calcutta.
- J. industr. Engng Chem.*—Journal of Industrial and Engineering Chemistry. Easton, Pa.
- J. Instn Chem. India*—Journal and Proceedings of the Institution of Chemists (India). Calcutta.
- J. int. Soc. Leath. Chem.*—Journal of the International Society of Leather Trades Chemists. London.
- J. Linn. Soc. (Bot.)*—Journal of the Linnean Society (Botany). London.
- J. Malaria Inst. India*—Journal of the Malaria Institute of India. Calcutta.
- J. Mysore For. Assoc.*—Journal of the Mysore Forest Association. Mysore.
- J. Mysore Univ.*—Journal of the Mysore University. Mysore.
- J. Nutr.*—Journal of Nutrition. Baltimore.
- J. Okayama med. Soc.*—Journal of the Okayama Medical Society. Okayama.
- J. Pharmacol.*—Journal of Pharmacology and Experimental Therapeutics. Baltimore.
- J. Pharm. Anvers.*—Journal de pharmacie. Anvers.
- J. pharm. Belg.*—Journal de pharmacie de Belgique. Bruxelles.
- J. Pharm. Chim., Paris*—Journal de pharmacie et de chimie. Paris.
- J. Pharm., Lond.*—Journal of Pharmacy and Pharmacology. London.
- J. pharm. Soc. Japan*—Journal of the Pharmaceutical Society of Japan. Tokyo.
- J. Physiol.*—Journal of Physiology. London and Cambridge.
- J. prakt. Chem.*—Journal fur praktische chemie. Leipzig.
- J. roy. Soc. N.S.W.*—Journal and Proceedings of the Royal Society of New South Wales. Sydney.
- J. sci. industr. Res.*—Journal of Scientific and Industrial Research. Delhi.
- J. Soc. chem. Ind. Lond.*—Journal of the Society of Chemical Industry. London.
- J. Soc. phys.-chim. russe*—Journal of the Russian Physical and Chemical Society.
- Jt. Publ. Commonw. agric. Bur.*—Joint Publications. Imperial (Commonwealth) Agricultural Bureaux. Aberystwyth.
- J. Univ. Bombay*—Journal of the University of Bombay (a) Biological Sciences; (b) Physical Sciences.
- J. Wash. Acad. Sci.*—Journal of the Washington Academy of Sciences. Washington.
- Kew Bull.*—Kew Bulletin. Royal Botanic Gardens. Kew.
- Khim. ref. Zh.*—Khimicheskii Referativnii Zhurnal. Moscow.
- Klin. W'schr.*—Klinische Wochenschrift. Berlin.
- Koninkl. Ned. Akad. Wetenschap, Proc.*—Koninklijke Nederlandse Akademie van Wetenschappen, Proceedings.
- Lancet.*—Lancet. London.
- Liebigs Ann.*—Liebigs Annalen der Chemie. Leipzig.
- Lijecn. Vijesn.*—Lijecnicki Vijesnik. u Zagrebu.
- Madras agric. J.*—Madras Agricultural Journal. Madras.
- Malay. agric. J.*—Malayan Agricultural Journal. Kuala Lumpur.
- Meded. PTTuin, Batavia*—Mededeelingen uit's Lands Plantentuin. Batavia.
- Med. Klinik*—Medizinische Klinik. Wien.
- Med. Mschr.*—Medizinische Monatsschrift. Zeitschrift fur allgemeine Medizin und Therapie.
- Med. Welt.*—Medizinische Welt. Berlin.
- Merck's Jber.*—Merck's Jahresbericht uber Neuerungen auf d. Geb. d. Pharmakotherapie u. Pharmazie. Darmstadt.
- Mfg. Chem.*—Manufacturing Chemist. London.
- Mh. Chem.*—Monatshefte fur Chemie und verwandte Teile anderer Wissenschaften. Wien.
- Milchw. Forsch.*—Milchwirtschaftliche Forschungen. Berlin.
- Misc. Bull. imp. Coun. agric. Res. India*—Miscellaneous Bulletins. Imperial (Indian) Council of Agricultural Research, India. Delhi.
- Mitt. naturf. Ges. Bern.*—Mitteilungen der Naturforschenden Gesellschaft in Bern.

- Natural appl. Sci. Bull.*—Natural and Applied Science Bulletin. University of the Philippines. Manila.
- Nature, Lond.*—Nature. London.
- Ned. Tijdschr. Pharm. Chem. Toxic.*—Nederlandsch tijdschrift voor pharmacie chemie en toxicologie. S' Gravenhage.
- Oil Fat Industr.*—Oil and Fat Industries. New York.
- Oil & Soap*—Oil and Soap. Chicago.
- Onderstepoort J. vet. Sci.*—Onderstepoort Journal of Veterinary Science and Animal Industry. Onderstepoort, Pretoria.
- Ost. Apothker. Ver.*—Österreichische Apotheker-Zeitung.
- Ost. bot. Z.*—Österreichische botanische Zeitschrift. Wien.
- Pacif. Sci.*—Pacific Science. Honolulu.
- Parfum. mod.*—Parfumerie moderne. Paris.
- Parfums de Fr.*—Parfums de France. Paris.
- Patna Univ. J.*—Patna University Journal. Patna.
- Perfum. essent. Oil Rec.*—Perfumery and Essential Oil Record. London.
- Pflanzer*—Pflanzer. Zeitschrift für Land- u. Forstwirtschaft in Deutsch-Ostafrika. Dar-es-Salam.
- Pharm. Acta Helvet.*—Pharmaceutica Acta Helvetica. Zurich.
- Pharmazie*—Pharmazie. Berlin.
- Pharm. Ind., Berl.*—Pharmazeutische Industrie. Berlin.
- Pharm. J.*—Pharmaceutical Journal and Pharmacist. London.
- Pharm. J. Trans.*—Pharmaceutical Journal and Transactions. London.
- Pharm. Mh.*—Pharmazeutische Monatshefte. Wien.
- Pharm. Post*—Pharmazeutische Post. Wien.
- Pharm. Pr.*—Pharmazeutische Presse. Wien.
- Pharm. Rev.*—Pharmacological Reviews. Baltimore.
- Pharm. & Toxic.*—Pharmacology and Toxicology. Moscow.
- Pharm. Weekbl.*—Pharmaceutisch weekblad voor Nederland. Amsterdam.
- Pharm. Zentralh.*—Pharmazeutische Zentralhalle f. Deutschland. Dresden.
- Pharm. Z. Russland*—Pharmazeutische Zeitschrift für Russland.
- Pharm. Ztg, Berl.*—Pharmazeutische Zeitung. Berlin.
- Philipp. Agric.*—Philippine Agriculturist. Los Banos.
- Philipp. J. Sci.*—Philippine Journal of Science. Manila.
- Prakt. Akad. Athen.*—Praktika tes Akademias Anthenon.
- Pr. med*—Presse medicale. Paris.
- Proc. Acad. Sci., Unit. Prov.*—Proceedings of the Academy of Sciences of the United Provinces of Agra and Oudh. Allahabad.
- Proc. Amer. Soc. hort. Sci.*—Proceedings. American Society for Horticultural Science. College Park, Md.
- Proc. chem. Soc. Lond.*—Proceedings of the Chemical Society. London.
- Proc. imp. Acad. Japan.*—Proceedings of the Imperial Academy (of Japan). Tokyo.
- Proc. Indian Acad. Sci.*—Proceedings of the Indian Academy of Science. Bangalore.
- Proc. Indian Sci. Congr.*—Proceedings of the Indian Science Congress. Calcutta.
- Proc. Lenin Acad. agric. Sci.*—Proceedings of the Lenin Academy of Agricultural Sciences of the U.S.S.R.
- Proc. nat. Acad. Sci. India*—Proceedings of the National Academy of Sciences, India. Allahabad.
- Proc. nat. Inst. Sci. India*—Proceedings of the National Institute of Sciences of India. Calcutta. Delhi.
- Proc. R. Irish Acad.*—Proceedings of the Royal Irish Academy. Dublin.
- Proc. roy. Soc.*—Proceedings of the Royal Society. London.
- Proc. Soc. biol. Chem. India*—Proceedings of the Society of Biological Chemists, India. Bangalore.
- Proc. Soc. exp. Biol., N.Y.*—Proceedings of the Society for Experimental Biology and Medicine. New York.
- Puerto Rico J. publ. Hlth*—Puerto Rico Journal of Public Health. San Juan.
- Quart. J. Indian Inst. Sci.*—Quarterly Journal of the Indian Institute of Science. Bangalore.
- Quart. J. Pharm.*—Quarterly Journal (and yearbook) of Pharmacy and Allied Sciences (and Pharmacology). London.

- Rass. econ. colonie Italy*—Rassegna economica delle colonie (Italy).
- Rec. Trav. chim. Pays-Bas*—Recueil des travaux chimiques des Pays-Bas et de la Belgique. Leyde.
- Rep. Bd sci. Adv. India*—Report of the Board of Scientific Advice for India. Calcutta.
- Rep. Cacao Res. Trinidad*—Report. Cacao Research. Imperial College of Tropical Agriculture. Port of Spain.
- Repert. Pharm.*—Repertorium der Pharmazie, Berlin.
- Rep. gen. Chim. appl.*—Repertoire general de chimie pure et appliquee. Paris.
- Rep. Hung. agric. Exp. Sta.*—Report of the Hungarian Agricultural Experiment Stations. Budapest.
- Rep. Indian Mus.*—Report of the Indian Museum, Natural History Section. Calcutta.
- Rep. Mysore agric. Dep.*—Report of the Department of Agriculture, Mysore. Bangalore.
- Rep. Pharm.*—Repertoire de pharmacie et Archives de pharmacie. Paris.
- Rep. P.R. agric. Exp. Sta.*—Report Porto Rico (Federal) Agricultural Experiment Station, Mayaguez. Washington.
- Rep. Sch. trop. Med. Calcutta*—Report. School of Tropical Medicine. Calcutta.
- Rep. vet. Res. S. Afr.*—Report on (of Director of) Veterinary Research (Series). Department of Agriculture, Union of South Africa. Pretoria.
- Rev. Asoc. med. argent.*—Revista de la Asociacion medica argentina. Buenos Aires.
- Rev. clin. esp.*—Revista clinica esparola. Madrid.
- Rev. esp. Fisiol.*—Revista espanola de fisiologia. Barcelona.
- Rev. Fac. Cienc. quim. La Plata*—Revista de la Facultad de ciencias quimicas (de quimica y farmacia). La Plata.
- Rev. filip. Med.*—Revista filipina de medicina y farmacia. Manila.
- Rev. Flora med.*—Revista da flora medicinal. Rio de Janeiro.
- Rev. Inst. bact., B. Aires*—Revista del Instituto bacteriologico, Buenos Aires.
- Rev. med. lat.-amer.*—Revista medica latino-americana. Buenos Aires.
- Rev. quim.-farm., Santiago*—Revista quimico-farmaceutica. Santiago de Chile.
- Rev. Quim. industr., Rio de J.*—Revista de quimica industrial. Rio de Janeiro.
- Rev. sudamer. Endocr.*—Revista sudamericana de endocrinologia, inmunologia y quimioterapia. Buenos Aires.
- Riv. ital. Essenze*—Rivista italiana delle essenze e profumi. Milano.
- Roczn. Chem.*—Rocznik Chemji. Warszawa.
- S. Afr. J. med. Sci.*—South African Journal of Medical Sciences. Johannesburg.
- S. Afr. J. Sci.*—South African Journal of Science. Cape Town.
- Schimmel Rep.*—Reports on Essential Oils, Synthetic Perfumes, etc. Schimmel & Co., Miltitz-Leipzig.
- Schweiz. ApothZtg.*—Schweizerisch Apothekerzeitung. Zurich.
- Schweiz. med. Wschr.*—Schweizerische medizinische Wochenschrift. Basel.
- Sci. & Cult.*—Science and Culture. Calcutta.
- Science*—Science. New York.
- Sci. Pap. Inst. phys. chem. Res. Tokyo*—Scientific Papers of the Institute of Physical and Chemical Research. Tokyo.
- Sci. pharm.*—Scientia pharmaceutica. Wien.
- Sci. Rec., Chungking*—Science Record. Chungking.
- Sci. Technol. China*—Science and Technology in China. Nanking.
- Seifensiederztg*—Seifensiederzeitung. Augsburg.
- Semana med. B. Aires*—Semana medica. Buenos Aires.
- Soap sanit. Chem.*—Soap (and Sanitary Chemicals). New York.
- Sovetsk. vrach. Zh.*—Sovietskii Vrachebnyi Zhurnal. Moscow, Leningrad.
- Soviet. Med., Moscow*—Sovietskaya Medicina. Moscow.
- Soviet Plant Ind. Rec.*—Soviet Plant Industry Record. Moscow, Leningrad.
- Trans. Bose Res. Inst.*—Transactions of the Bose Research Institute. Calcutta.
- Trans. chem. Soc.*—Transactions of the Chemical Society. London.
- Trans. roy. Soc. trop. Med. Hyg.*—Transactions of the Royal Society of Tropical Medicine and Hygiene. London.

- Trav. Lab. Biogeochim. U.S.S.R.*—Trudy Biogekhimicheskoi Laboratorii. Akademia Nauk U.S.S.R. Leningrad.
- Trib. farm.*—Tribuna farmaceutica. Curitiba.
- Trop. Agriculturist*—Tropical Agriculturist and Magazine of the Ceylon Agricultural Society. Peradeniya.
- Trop. Dis. Bull.*—Tropical Diseases Bulletin. London.
- Trud. nauch. khim.-farm. Inst. Mosk.*—Trudy Nauchnovo Khimiko-Farmatsevticheskovo Instituta. Moscow.
- Univ. Allahabad Studies*—Allahabad University Studies. Allahabad.
- Vet. J.*—Veterinary Journal. London.
- West. J. Surg.*—Western Journal of Surgery, Obstetrics and Gynecology, Portland, Ore.
- Wiad. farm.*—Wiadomosci Farmaceutyczne. Warszawa.
- Wien. med. Wschr.*—Wiener medizinische Wochenschrift. Wien.
- Yearb. Pharm.*—Yearbook of Pharmacy. London.
- Z. allg. öst. ApothVer.*—Zeitschrift des Allgemeinen Österreichischen Apothekervereins. Wien.
- Zbl. Physiol.*—Zentralblatt für Physiologie. Leipzig.
- Z. ges. exp. Med.*—Zeitschrift für die gesamte experimentelle Medizin. Berlin.
- Zh. prikl. Khim. Mosk.*—Zhurnal Prikladnoi Khimii. Moscow.
- Z. Untersuch. Lebensmitt.*—Zeitschrift für Untersuchung der Lebensmittel. Berlin.
- Z. Vitaminforsch.*—Zeitschrift für Vitaminforschung. Bern.

ABBREVIATIONS USED

Abortifacient	abortif.	Galactagogue	galact.
Absorbent	absorb.	Glycoside	glucd.
Alkaloid	alk.	Gonorrhoea	gonor.
Alterative	alter.	Hindi	H.
Amenorrhoea	amenor.	Haematuria	haemat.
Amorphous	amorph.	Haemorrhage	haemor.
Antibilious	antibil.	Indian Bazzars	Ind. baz.
Anthelmintic	anthelm.	Indigestion	indign.
Antidote	antid.	Inflammation	inflam.
Antidysenteric	antidysen.	Irritant	irrit.
Antilithic	antilith.	Kanarese	Kan.
Antimalarial	antimal.	Kashmir	Kash .
Antiperiodic	antiper.	Lactagogue	lactag.
Antiphlegmatic	antiphlegm.	Laxative	laxt.
Antiphlogistic	antiphlog.	Leucorrhoea	leucor.
Antipyretic	antipyr.	Madras State	M.
Antiscorbutic	antiscor.	Malayalam	Mal.
Antiseptic	antisept.	Materia medica	mat, med.
Antispasmodic	antisp.	Menorrhagia	menor.
Antisyphilitic	antisyp.	Madhya Pradesh	M. P.
Aperient	aper.	Mucilage	mucil.
Aphrodisiac	aphrodis.	Nepal	Nep.
Arabic	Arab.	Nutritious	nutri.
Aromatic	arom.	Punjab	P.
Astringent	astrin.	Persian	Pers.
Bengal	B.	Phlegmatic	phlegm.
Bombay State	Bo.	Purgative	purg.
Bronchitis	broncht.	Reference	ref.
Burma	Burm.	Refrigerant	refrig.
Carminative	carmin.	Resolvent	resolv.
Catarrhal	catarr.	Restorative	restor.
Cathartic	cath.	Rheumatic	rheum.
Cholagogue	cholag.	Rubefacient	rubft.
Chronic	chr.	Sanskrit	S.
Constipation	constip.	Santhal	Santh.
Deccan	Dec.	Sialogogue	sialog.
Decoction	decoct.	Singhalese	Sing.
Demulcent	demulc.	Stimulant	stim.
Deodorant	deod.	Stomachic	stomch.
Diaphoretic	diaphor.	Substitute	subst.
Diarrhoeia	diar.	Synonym	syn.
Digestive	digest.	Tamil	Tam.
Diuretic	diur.	Telegu	Tel.
Dysentery	dysen.	Toxic	tox.
Dysmenorrhoea	dysmen.	Uttar Pradesh	U. P.
Dyspepsia	dyspep.	Variety	var.
Emmenagogue	emmen.	Vernacular	vern.
Emollient	emol.	Veterinary	vet.
Essential oil	essen. oil.	Vesicant	vesic.
Expectorant	expect.		
Febrifuge	febge.		

SECTION I

VEGETABLE, INORGANIC AND ANIMAL PRODUCTS, COMMONLY USED IN UNANI AND AYURVEDIC SYSTEMS OF MEDICINE

A. VEGETABLE PRODUCTS

[For detailed description of plants marked with 'asterisks' refer to Parts II & III and 'asterisk' within the text denote drugs whose investigation is likely to be useful]

ABROMA (*Sterculiaceae*)

* A. AUGUSTA Linn. f.

ABRUS (*Leguminosae*)

* A. PRECATORIUS Linn.

ABUTILON (*Malvaceae*)

A. INDICUM (Linn.) Sw. syn. *A. indicum* G. Don. H.—Khanghi; B.—Potari; Bo.—Kangori; S.—Kankati; Tam.—Paniyarattutti; Tel.—Tutturubenda. Leaves—demulc. Bark—astrin., diur. Infusion of roots—in fevers. Seeds—aphrodis., laxt., demulc. Mucil., asparagin (Dymock, Warden & Hooper, I, 209; *Pflanzer*, 1909, 8). Throughout the hotter parts of India.

ACACIA (*Leguminosae*)

A. ARABICA Willd. II.—Kikar; B.—Babla, Babul; Bo.—Babhula, Kikar; S.—Babbula; Tam.—Karu velum; Tel.—Nallatunma. Gum—in diar., dysen., useful in diabetes mellitus. Bark—astrin., demulc. Leaves and fruits contain tannin 32% (*Arch. Pharm., Berl.*, 1910, 171); fruit contains tannin 41.7% (*Bull. imp. Inst. Lond.*, 1930, 1). Naturalized in all parts of India, indigenous to Sind and the Deccan.

A. CATECHU Willd. S.—Khadira; H.—Khair; Bo.—Khaderi; B.—Kuth; Tam.—Kargalli; Tel.—Khadiram. Bark—astrin. Catechin, catechutannic acid, tannin (*Proc. Chem. Soc. Lond.*, 1902, 139; 1904, 171; 1905, 398); wood contains α , β and γ -catechin (*J. Indian Chem. Soc.*, 1930, 279; 1931, 143); l-epicatechin (*J. Sci. Industr. Res.*, B 1948, 59). Punjab, N.W. Himalayas, Madhya Bharat, Bihar, Ganjam, throughout the Konkan, S.M. country, Deccan.

A. CONCINNA DC. B.—Ban-ritha; Bo.—Shika; H.—Ritha; S.—Saptala; Tam.—Shikai; Tel.—Shikaya. Pods—aper., expect., emetic. Leaves—cath., in biliousness. Saponin, alk. (*Arch. Pharm., Berl.*, 1905, 247). Tropical jungles throughout India, especially in the Deccan.

A. FARNESIANA Willd. S.—Arimaedah; H.—Gand-babul; B.—Guya-babula; Bo.—Deobabul; Tam.—Kasturivel; Tel.—Kasturitumma. Bark—astrin., demulc. Essen. oil (*Schimmel Ber.*, 1901, April, 16; 1903, April, 16; 1904, April, 21); pods 23% tannin (Kurkill, I, 21). Throughout India, often planted in gardens.

A. SENEGAL Willd. Bo.—Khor; Rajasthan—Kumta; S.—Svetakhadira. Gum—demulc., emol., internally used in inflam. of intestinal mucosa, externally to cover inflamed surface, such as burns, sore nipples, etc. Punjab, Rajasthan, Sind, Baluchistan.

A. SUMA Buch.-Ham. syn. *A. suma* Kurz. B.—Saikanta; S.—Shami; Tam.—Kovil; Bark—astrin. yields gum. Bengal, Bihar, W. Peninsula.

ACALYPHA (*Euphorbiaceae*)

A. FRUTICOSA Forsk. Deccan & Tel.—Chinni; Tam.—Sinmi. Leaves—stomch., in dyspep., alter. and attenuant. S. India, Madras, Pondicherry, Mysore, Carnatic.

ACHYRANTHES (*Amaranthaceae*)

A. ASPERA Linn. H.—*Latjira*; B.—*Apang*; P.—*Kutri*; S.—*Apamarga*; Tam.—*Nayurivi*; Tel.—*Uttareni*. Plant—pungent, purg., diur., in dropsy, piles, boils, skin eruptions, colic, snake-bite. Infusion of roots—astrin. Seeds—emetic, in hydrophobia (*Chem. News*, 1891, 147; *Pharm. J.*, 1888; 946). Throughout India up to 3,000 ft. as a weed, Baluchistan.

ACONITUM (*Ranunculaceae*)

* A. HETEROPHYLLUM Wall.

* A. NAPELLUS Linn.

ACORUS (*Araceae*)

* A. CALAMUS Linn.

ACTINIOPTERIS (*Polypodiaceae*)

A. DICHOTOMA Bedd. Bo.—*Mayursikha*; H.—*Morpankhi*; S.—*Mayurshikha*. Plant—used as a styptic and anthelm. Throughout India, especially the Peninsula, in dry rocky places, below 4,000 ft. Common in the Nilgiris up to 2,000 ft. and in Kumaon.

ADANSONIA (*Bombacaceae*)

A. DIGITATA Linn. H. & Bo.—*Gorakh-amli*; S.—*Gorakshi*; Tam.—*Papparappuli*; Tel.—*Simachinta*. Fruit pulp—aper., demulc., astrin., in dysen. Leaves—used as diaphor. and as a prophylactic against fevers in Africa. Adansonin (*Wehmer*, II, 765; *J. Soc. Chem. Ind. Lond.*, 1913, 778). A native of tropical Africa, occasionally cultivated in some parts of Uttar Pradesh, Bihar, Bombay and Madras.

ADHATODA (*Acanthaceae*)

* A. VASICA Nees

ADIANTUM (*Polypodiaceae*)

A. LUNULATUM Burm. H. & B.—*Kali-jhant*; Bo.—*Hansraj*; S.—*Hansavati*. Used in fever and erysipelas. Throughout N. India in moist places, S. India very common on western side in the plains and lower slopes of hills.

AEGLE (*Rutaceae*)

* A. MARMELOS Corr.

AILANTHUS (*Simarubaceae*)

A. EXCELSA Roxb. H. & Marathi—*Maharukha*; S.—*Mahanimba*; Tam.—*Peruppi*; Tel.—*Peddamanu*; Mal.—*Mattipongilyam*. Bark—arom., used for dyspeptic complaints, tonic, febrige., expect., antisp., given in chr. bronchit. and asthma, used as astrin. in diar. and dysen. Bark and leaves—tonic, used especially in debility after child-birth. Ailantic acid (*Pharm. J.*, 1895, 345). Bihar, Chota Nagpur, Madhya Pradesh, forests of Ganjam, Vizagapatam and Deccan.

ALANGIUM (*Alangiaceae*)

* A. LAMARCKII Thwaites; see A. SALVIFOLIUM (Linn. f.) Wang.

ALBIZZIA (*Leguminosae*)

A. LEBBECK Benth. S.—*Shirisha*; H., B. & Bo.—*Siris*; Tam.—*Vagai*; Tel.—*Dirasana*. Plant—in snake-bite and scorpion-sting. Bark and seeds—astrin., given in piles and diar., tonic, restor. Root bark—in powder form used to strengthen gums. Leaves—in night-blindness. Gum, saponin and tannin (*Wehmer*, I, 485). Throughout India, ascends to 4,000 ft. in the Himalayas, usually planted.

A. ODORATISSIMA Benth. H.—*Kala siris*; B.—*Kakur siris*; Marathi—*Chikunda*; Tam.—*Karuvagei*; Tel.—*Chinduga*; S.—*Svetashirisha*. Bark—applied externally is considered efficacious in leprosy and inveterate ulcers. Leaves—boiled in ghee used as remedy for cough. Gum (*Wealth of India*, I, 44). Throughout India, up to 5,000 ft. in the sub-Himalayan tract.

ALHAGI (*Leguminosae*)

A. PSEUDALHAGI (Bieb.) Desv. syn. *A. camelorum* Fisch.; *A. maurorum* Baker. B.—*Dulal-labah*; H.—*Jawasa*; Pers.—*Kharebuz*; S.—*Durlabha*; Tel.—*Tellaginiya*. Plant—laxt., diur., expect. Infusion—diaphor. Oil from leaves—used for rheumatism. Flowers—

used for piles. Manna (*Pharm. J.*, 1912, 35(4) 391; *J. Chem. Soc.*, 1885, 943; *J. Amer. Chem. Soc.*, 1918, 1456; *Chem. Abstr.*, 1937, 3104). S.M. Country, Gujarat, Sind, Baluchistan, Punjab, Uttar Pradesh, Rajasthan.

ALLIUM (*Liliaceae*)

A. CEPA Linn. S.—*Palandu*; H.—*Piyas*; B.—*Piyaj*; Bo.—*Kanda*; Tel.—*Nirulli*; Tam.—*Irulli*, *Vengayam*. Bulbs—stim., diur., expect., aphrodis., emmen., in flatulence and dysen. Essen. oil and organic sulphides (*Pharm. Ztg. Berl.*, 1903, 315; *Schimmel Ber.*, 1889, April, 44; *Arch. Pharm. Berl.*, 1892, 434); scales contain catechol and protocatechuic acid (*J. Biol. Chem.*, 1933, 379; *Chem. Zbl.*, 1933, II, 3299); essen. oil 0.05% of whole plant (*Parfums de Fr.*, 1937, 228; *Chem. Abstr.*, 1938, 727); contains a heart stimulant, increases pulse volume and frequency of systolic pressure and coronary flow, stimulates intestinal smooth musculature and uterus, promotes bile production and reduces blood sugar *Merck's Jber.*, 1936, 102; *Chem. Abstr.*, 1937, 3194); chief constituent of the crude oil is allyl-propyl disulphide (*J. agric. Res.*, 1935, 847); fresh expressed juice moderately bactericidal (*Chem. Abstr.*, 1941, 2627, 2552). Extensively cultivated all over India.

* A. SATIVUM Linn.

ALOE (*Liliaceae*)

* A. BARBADENSIS Mill. syn. *A. vera* Tourn. ex Linn.

* A. INDICA Royle; see *A. BARBADENSIS* Mill.

ALPINIA (*Zingiberaceae*)

* A. GALANGA Willd.

A. OFFICINARUM Hance H.—*Kulinjan*; B.—*Sugandha bacha*. Rhizomes—stomch., stim., carmin. Essen. oil, galangin (*Pharm. J., Trans.*, 1884, 208); essen. oil (*Schimmel Ber.*, 1890, April, 21; *Gazz. chim. ital.*, 1900, 327). A native of China.

ALSTONIA (*Apocynaceae*)

* A. SCHOLARIS R. Br.

ALTINGIA (*Hamamelidaceae*)

A. EXCELSA Noronha H.—*Silaras*; Tam.—*Neriyuriskippal*; Tel.—*Shilarasamu*; S.—*Silhasara*; Assam—*Jutuli*. Resin—carmin., expect., stomch., antiscor., applied in scabies and leucoderma. Benzaldehyde, cinnamic aldehyde (*Arch. Pharm., Berl.*, 1901, 506). Assam, Bhutan.

AMOMUM (*Zingiberaceae*)

A. SUBULATUM Roxb. S.—*Brihadacla*; H. & B.—*Bara-clachi*; Tam.—*Periyayelam*; Tel.—*Pedayelaki*. Seeds—stomch., useful in neuralgia, used in gonorr. as aphrodis., antid. to scorpion-sting and snake-bite. Oil from seeds—arom., stim., stomch., applied to eyelids to allay inflam. Eseen. oil. Cultivated in swampy places along the sides of mountain streams in Nepal, Bengal, Sikkim and Assam.

AMORPHOPHALLUS (*Araceae*)

A. CAMPANULATUS (Roxb.) Bl. S.—*Arsaghna*; Bo.—*Jungli suran*; B.—*Ol*; H.—*Zamin-kand*; Tam.—*Karnaikilangu*; Tel.—*Kanda*; Mal.—*Chena*. Tuber—stomch., tonic, restor., carmin., in piles and dysen., when fresh acts as an acrid stim. and expect. and much used in acute rheumatism. Enzyme (*J. Indian Chem. Soc.*, 1944, 223). Cultivated largely throughout the plains of India.

ANACYCLUS (*Compositae*)

A. PYRETHRUM DC. S.—*Akara-karava*; H., B. & Bo.—*Akarakara*; M.—*Akkirakaram*. Cordial, stim., sialog., in rheumatism. Essen. oil, pellitorine or pyrethrin (*Chem. News* 1895, 94, 100; *Ber. dtsh. chem. Ges.*, 1927, 2284; 1928, 246; *J. chem. Soc.*, 1930, 6)*. Indigenous to North Africa, whence it has been introduced into South Europe.

ANAMIRTA (*Menispermaceae*)

A. COCCULTA (Linn.) W. & A. syn. *A. paniculata* Colebr. Bo.—*Kakaphala*; H., S. & Gujarati—*Kakamari*; B.—*Kakamari*; Mal.—*Garaphala*; Tel.—*Kakamari*, *Koditige*. Plant—fish poison. Seeds—in night sweats of phthisis. Ointment prepared from drupes—

used as insecticide, to destroy pediculi and chr. skin diseases. Picrotoxin, cocculin, anamirtin (*Ber. dtisch. chem. Ges.*, 1881, 817; 1898, 2958; *Chem. Abstr.*, 1942, 2348; Wehmer, I, 333; *J. Amer. Chem. Soc.*, 1935, 111); pericarp—alks. menispermene and paramenispermene, both pharmacologically inactive, toxicity due to picrotoxin (Henry, 1939, 366).* Khasia Hills, Orissa, E. Bengal, Deccan (Cuddapah, Malabar and Mysore).

ANDROGRAPHIS (*Acanthaceae*)

* *A. PANICULATA* Nees

ANISOCHILUS (*Labiatae*)

A. CARNOSUS Wall. H.—*Panjiri-ka-pat*; Bo.—*Kapurli*; Dec.—*Panjirikapatta*; Mal.—*Patukurkka*; Tel.—*Karpuravalli*; Tam.—*Karppuravalli*. Plant—stim., expect., useful in cough of children. Juice of fresh leaves—cooling, mixed with sugar-candy given for coughs and colds. Essen. oil. W. Himalayas, Bengal, Madhya Bharat, N. Circars, Deccan, Carnatic.

ANOGEISSUS (*Combretaceae*)

A. LATIFOLIA Wall. H.—*Bakla*, *Dhaura*; B.—*Dhaoya*; Bo.—*Dhavada*; S.—*Dhava*; Tam.—*Vellaynaga*; Tel.—*Chirimani*; Mal.—*Marukinchiram*. Bark—bitter, astrin. Plant—in scorpion-sting and snake-bite. Tannin (*Bull. imp. Inst., Lond.*, 1929, 452; 1931, 137); yields gum which is a good subst. for gum arabic (Martindale, 1, 2); gum is chiefly built up of pentoses and galactose (Wehmer, I, 824). Common in dry deciduous forests throughout India except E. Bengal and Assam. Found in the sub-Himalayan tract from the Ravi to Nepal, Bihar, Chota Nagpur, Madhya Bharat and southwards to Ceylon. Ascends to 4,000 ft. in the Himalayas and the South Indian hills.

ANTHOCEPHALUS (*Rubiaceae*)

A. CADAMBA Miq. see *A. INDICUS* A. Rich.

A. INDICUS A. Rich. syn. *A. cadamba* Miq.; *Nauclea cadamba* Roxb. S., Bo. & H.—*Kadamba*; Tam.—*Vellai-cadamba*; Tel.—*Kadambamu*. Bark—tonic, febg., astrin., in snake-bite. Decoct. of leaves—used as gargle in cases of aphthae and stomatitis. Principle similar to cinchotannic acid. Sub-Himalayan tract from Nepal eastwards to Burma, and in south in N. Circars and W. Ghats.

APIUM (*Umbelliferae*)

A. GRAVEOLENS Linn. S.—*Ajamoda*; H.—*Ajmod*; B.—*Chanu*, *Randhuni*; S. India—*Ajmod*. Root—alter., diur., given in anasarca and colic. Seeds—stim., cordial, tonic, carmin., diur., emmen., as antisp. used in bronchit., asthma and for liver and spleen diseases. Essen. oil, glucd., apiin (*Schimmel Ber.*, 1909, Oct., 105; 1910, April, 95; *Ann. Chim. (Phys.)*, 1843, 250); contracts gravid and virginal uteurs (*Merck's Jber.*, 1936, 102; *Chem. Abstr.*, 1934, 3149); fruits yield 2-3% of a pale yellow volatile oil which consists of *d*-limonene 60, *d*-selinene 10, sedanonic acid anhydride 0.5, and sedanolide 2.5-3% (Finnemore, 644; Wehmer, II, 876). Foot of the N. W. Himalayas and outlying hills in the Punjab and Uttar Pradesh.

AQUILARIA (*Thymelaeaceae*)

A. AGALLOCHA Roxb. S. & B.—*Agaru*; Bo.—*Hindiagara*; H. & Tam.—*Agar*; Tel.—*Agru*. Wood—stim., carmin., tonic, aphrodis., astrin. in diar. and vomiting, in snake-bite. Essen. oil (*Perfum. essent. Oil Rec.*, 1927, 139; *Schimmel Ber.*, 1928, 3). E. Himalayas, Bhutan, parts of Bengal and particularly in Assam on the hill forests of Khasia, Garo, Naga, Cachar and Sylhet.

ARECA (*Palmae*)

* *A. MEXICANA* Linn.

ARGEMONE (*Papaveraceae*)

* *A. MEXICANA* Linn.

ARGYREIA (*Convolvulaceae*)

A. SPECIOSA Sweet syn. *Lettsomia nervosa* Roxb. H.—*Samandarka-pat*; B.—*Bichtarak*; Bo.—*Guguli*. Root—alter., tonic, useful in rheumatism. Leaves—entipl., used in skin diseases (Murray, *Drugs of Sind*). Fatty oil (*J. Indian chem. Soc.*, 1947, 83).

Throughout India (except in dry western regions) up to an elevation of 1,000 ft., often cultivated.

ARISTOLOCHIA (*Aristolochiaceae*)

A. BRACTEATA Retz. S.—*Dhumrapatra*; H.—*Kiramar*; Bo.—*Kidamari*; Tam. & Mal.—*Aduthinapalai*; Tel.—*Adumuttada-gida*. Plant—purg., anthelm., emmen. Juice of leaves—applied to foul and neglected ulcers. Bruised leaf—mixed with castor oil applied to eczema on children's legs. Decoct. of root—used for expelling roundworms. Volatile substance and alk. (*Pharm. J.*, 1891-92, 551; Dymock, Warden & Hooper, III, 163; *Arch. exp. Path. Pharmacol.*, 1891, 232; Henry, 1924, 376).* Bengal, Upper Gangetic Plain, Bundelkhand, Sind, Konkan, N. Circars, Deccan, Carnatic.

* A. INDICA Linn.

ARTEMISIA (*Compositae*)

* A. MARITIMA Linn.

A. VULGARIS Linn. S.—*Nagadamani*; H.—*Nagadouna*; B. & Bo.—*Nagadona*; Tam.—*Mashibattiri*, *Machipatri*; Tel.—*Machipatri*; P.—*Tarkha*. Herb—emmen., anthelm., antisp., stomch. Root—tonic, antisp. Infusion of leaves and flowering tops—administered in nervous and spasmodic affections, in asthma and diseases of the brain. Essen. oil (*Schimmel Ber.*, 1904, April, 97; 1913, April, 24; *Bull. imp. Inst.*, Lond., 1913, 436; *J. Pharm. Soc., Japan*, 1924, 510); adenin (*J. Pharm. Soc., Japan*, 1933, 47; *Chem. Zbl.*, 1933, I, 3736); plant yields 0.2% volatile oil (Welmer, II, 1244); oil good larvicide and a feeble insecticide (*J. Malur. Inst. India*, 1940, 495).* Throughout the mountainous districts of India, ascending up to 5,000-12,000 ft. in the W. Himalayas, and up to 5,000-8,000 ft. in Sikkim and Khasia, Mt. Abu in Rajasthan and W. Ghats from Konkan southwards to Ceylon.

ARTOCARPUS (*Moraceae*)

A. HETEROPHYLLUS Lam. syn. *A. integrifolia* Linn. f. S. & Tel.—*l'anasu*; H. & B.—*Kathal*, *Kanthal*; Bo.—*Phanas*; Tam.—*Pilapalam*. Leaves—used in skin diseases, antid. to snake-bite. Root—used internally in diar. Juice of plant—applied to glandular swellings and abscesses to promote suppuration. Unripe fruit—astrin. Ripe fruit—laxt. Wood yields colouring matter morin and cyanomaclurin (Welmer, I, 245; *J. Chem. Soc.*, 1895, 337; *Proc. Chem. Soc., Lond.*, 1902, 139; 1904, 170); bark contains 3.3% tannin (Burkill, I, 255); crystalline steroketone, artostenone isolated from the latex (*Sci. & Cult.*, 1935-36, 434; 1937-38, 57); artostenone has been converted to artosterone, a compound with highly androgenic properties (*Indian J. med. Res.*, 1939, 171)* Indigenous to India, probably the W. Ghats where it grows wild. Grown plentifully throughout the warmer parts of the country, especially in Bengal, Bihar and the Deccan.

ASPARAGUS (*Liliaceae*)

A. ASCENDENS Roxb. H. & Marathi—*Safed musli*; Bo.—*Sapheta musali*; Garhwal—*Jhirna*; Gujarati—*Ujli musli*. Roots—demulc., galact., tonic, useful in diar., dysen. and general debility. Asparagin. Punjab and the Himalayas up to 5,300 ft.

A. RACEMOSUS Willd. S. & B.—*Shatanuli*; H.—*Satawar*; Bo.—*Satavari*; Tam.—*Shimai shadavari*; Tel.—*Challagadda*; Mal.—*Shatavali*. Root—refrig., demulc., diur., aphrodis., antisp., alter., antidiar., antidysen., galact. and as demulc. in veterinary medicine. Throughout tropical and subtropical India, up to 4,000 ft. in the Himalayas, from Kashmir eastwards.

ATROPA (*Solanaceae*)

* A. BELLADONNA Linn.

AZADIRACHTA (*Meliaceae*)

* A. INDICA A. Juss. syn. *Melia azadirachta* Linn.

BALANITES (*Simarubaceae*)

B. AEGYPTIACA (Linn.) Delile syn. *B. roxburghii* Planch. S.—*Ingudi*; H. & B.—*Hingan*; Bo.—*Hinganbet*; Tam.—*Nanjunda*; Tel.—*Gari*. Bark, unripe fruit and leaves—purg., anthelm. Seeds—expect., given in cough and colic. Plant—in snake-bite. Bark—used

as anthelm. for cattle and its juice as fish poison. Saponin (*Arch. Pharm., Berl.*, 1901, 363); seed kernels—a saponin, a tetra-glycoside of a sapogenin; acid hydrolysis gives nitrogenin; it is an active haemolytic agent; toxicity for tadpoles similar to digitonin (*J. Chem. Soc.*, 1939, 800; *Chem. Abstr.*, 1939, 6325). Drier parts of India from south-east Punjab and Delhi to Sikkim, Bihar, Gujarat, Khandesh and the Deccan.

BALIOSPERMUM (*Euphorbiaceae*)

B. MONTANUM Muell.-Arg. S., H. & B.—*Danti*; Bo.—*Dantinul*; Mal.—*Naka-danti*; Tam.—*Niradinuttu*; Tel.—*Nelajidi*. Seeds—purg., used externally as stim. and rubft., and in snake-bite. Root—cath., used in dropsy, anasarca and jaundice. Decoct. of leaves—in asthma. Oil from seeds—hydrogogue cath., external application in rheumatism. Outer ranges of the Himalayas from Kashmir to Bhutan up to 3,000 ft., Assam, Khasia Hills, N. and E. Bengal, Bihar, from central and western India to Travancore.

BAMBUSA (*Gramineae*)

* B. ARUNDINACEA Willd.; see B. BAMBOS Druce.

BARRINGTONIA (*Lecythidaceae*)

B. ACUTANGULA (Linn.) Gaertn. S.—*Dhatrithala*; B.—*Hijal*; H.—*Hijjal*; Bo.—*Samundar-phal*; Tam.—*Kadappai*; Tel.—*Kadupa*; Marathi—*Pivvar*; M.—*Samulra-pallam*. Powdered seed—emetic, expect. and as snuff in headache. Bark, root and seed—fish poison. Leaves and roots—bitter tonic. Root—cooling, aper. Juice of leaves—in diar. Glucd.-saponin barringtonin (*Pharm. Weekbl.*, 1903, 729; *Proc. Indian Sci. Congr.*, 1937, 390); bark contains 16% tannin (*Indian For. Leafst.*, No. 72, 1944, 5). Common in the sub-Himalayan tracts, east of the Jumna, in Bihar, Orissa, Bengal, Assam, Madhya Pradesh and South India.

BASSIA (*Sapotaceae*)

* B. LATIFOLIA Roxb.; see MADHUCA INDICA J. F. Gmel.

BAUHINIA (*Leguminosae*)

B. PURPUREA Linn. S.—*Vanaraja*; H.—*Khairwal*, *Kaliar*; B. & Marathi—*Raktakanchan*; P.—*Koiral*; Tam.—*Mandari*; Tel.—*Kanchanam*. Bark—astrin. in diar. Root carmin. Flowers—laxt. Tree yields gum; bark contains tannin; seeds contain 15% of a non drying oil (*Chem. Abstr.*, 1933, 202; 1934, 5266). Sub-Himalayan tracts up to 4,000 ft., Assam, Khasia Hills, Chittagong, W. Peninsula. Often cultivated.

B. RACEMOSA Lam. S.—*Svetakanchan*; H.—*Kachnal*; B.—*Banraj*; Bo.—*Wanurajah*; P.—*Kosundra*; Tam.—*Arikka*; Tel.—*Pachare*; Mal.—*Kotapuli*. Gum—used medicinally. Decoct. of leaves—in headache and malaria. Bark—astrin., in diar. and dysen. Throughout India.

B. TOMENTOSA Linn. S.—*Aswamantaka*, *Phalgu*; H.—*Kachnar*; Bo.—*Asundro*; M.—*Mandarai*; Mal.—*Kanjanam*; Tam.—*Kanjani*; Tel.—*Kanjini*. Decoct. of root bark—given in inflam. of liver, anthelm. Buds and young flowers—in dysenteric affections. Fruit—diur. Plant—used in snake-bite and scorpion-sting. Bundelkhand, Circars, Carnatic, in dry forests from the Chilka Lake to Tinnevely, in other parts of India often cultivated.

BENINCASA (*Cucurbitaceae*)

B. HISPIDA (Thunb.) Cogn. syn. *B. cerifera* Savi. Arab.—*Majdhab*; B. & P.—*Chalkumra*; H.—*Petha*; Bo.—*Kohala*; S.—*Brihatphala*; Tam.—*Pushani kai*; Tel.—*Budida-gummadi*. Fruit—laxt., diur., tonic, aphrodis., antiper., specific for haemoptysis and other haemorrhages from internal organs. Juice of fruit—in insanity, epilepsy and other nervous diseases. Seeds—anthelm. Oil from seeds—anthelm. Vitamin B₁ (*Hlth. Bull.*, No. 23, 1941, 32). Cultivated more or less throughout the plains of India and on the hills up to 4,000 ft.

BERBERIS (*Berberidaceae*)

* B. ARISTATA DC.

* B. ASIATICA Roxb. ex DC.

BERGENIA (*Saxifragaceae*)

- B. LIGULATA (Wall.) Engl. syn. *Saxifraga ligulata* Wall. B.—*Patharchuri*; Bo.—*Pashanbheda*; H.—*Pakhanbed*; S.—*Pashanabheda*. Root—tonic, used in fever, diar. and pulmonary affections, antiscor., bruised and applied to boils and ophthalmia. Root contains gallic acid, tannic acid (14.2%), glucose (5.6%), mucilage, wax, etc. (Wehmer, I, 423). Temperate Himalayas, from Kashmir to Bhutan between 7,000 and 10,000 ft. and Khasia Hills at 4,000 ft.

BLUMEA (*Compositae*)

- B. BALSAMIFERA DC. H.—*Kakaronda*; Marathi—*Bhangaruda*; Gujarati—*Kalahad*. Warm infusion—sudorific. Decoct.—expect. Plant—fish poison. Camphor (*Philipp. J. Sci.*, 1909, A 127; *Schimmel Ber.*, 1910, April, 149; 1926, 8); leaves yield crystalline essen. oil, containing a camphor known as Ngai-camphor and a glucd.; injection of extract lowers blood pressure; used in the treatment of excitement, insomnia and hypertension (*Pr. med.*, 1940, 644; *Chem. Abstr.*, 1941, 2981). Subtropical Himalayas, Nepal, Sikkim, Assam, Khasia Hills and Chittagong at 2,000-4,000 ft.

BORASSUS (*Palmae*)

- B. FLABELLIFER Linn. syn. *B. flabelliformis* Roxb. S. & B.—*Tal*; H.—*Tar*; Marathi & Gujarati—*Tad*; Tam.—*Panai, Talai*; Tel.—*Tadi-chettu*; Mal.—*Pana*. Root—cooling, restor. Juice of plant—diur., stim., antiphlegm., useful in inflammatory affections and dropsy. Pulp—demulc., nutri. Nutritive value of the fresh sap called toddy depends on the small amount of sugar and yeast in it and the latter is a good source of vitamin B. complex (*Indian med. Gaz.*, 1942, 224). More or less all over India in the dry parts, common along the coastal areas of the peninsula, Bihar and Bengal.

BRASSICA (*Cruciferae*)

- B. CAMPESTRIS Linn. Tuberous roots and seeds—considered antiscor. Seeds yield oil of colza which is official in Sweden as oleum rape (*J. Amer. Chem. Soc.*, 1903, 690; *J. Soc. Chem. Ind., Lond.*, 1898, 992; *Chem. News*, 1895, 266). Naturalized in India.

- B. CAMPESTRIS Linn. var. RAPA (Linn.) Hartm. B. & H.—*Kali sarson*; S.—*Kala-sarshapa*; Mal.—*Karupakatuka*; Tam.—*Karuppukkadugu*; Tel.—*Nallaavalu*. Seeds—mixed with hot water form an efficient counter-irritant poultice. Oil—combined with camphor, forms an efficacious embrocation in muscular rheumatism, stiff neck, etc.; it is used in dengue fever with benefit, and is rubbed on the chest, in bronchit. Roots and leaves—considered stomch. in Indo China. Oil contains glycerides of erucic acid. Cultivated throughout India.

- B. INTEGRIFOLIA (West) O. E. Schulz B.—*Raisarisha*; Bo.—*Rai, Sarson*; H.—*Badshahirai*; S.—*Rajika*; Tam.—*Kadugu*. Seeds—warming, sudorific, used in spasmodic, neuralgic, and rheum. affections. Oil—used as an embrocation, applied to skin in eruptions and ulcers. Oil contains glycerides of erucic acid. Much cultivated in India in the Punjab, Assam and North Bengal.

- B. JUNCEA (Linn.) Czerna. & Coss. P.—*Asal rai*. Essen. oil (Wehmer, I, 438). Abundantly cultivated in Upper India; also in the low-lying hills of the Athur Taluk of Salem district in Madras State.

- B. NIGRA (Linn.) Koch B.—*Raisarisha*; H.—*Aslrai, Taramira*; Bo.—*Rai*; S.—*Madhurika*; Tam.—*Kadugu*; Tel.—*Avalu*. Seeds—stim., rubft., vesic., used in snake-bite. Glucd. sinigrin, essen. oil (*Arch. Pharm., Berl.*, 1863, 132, 214; 1897, 44; *Pharm. Weekbl.*, 1915, No. 39; *Schimmel Ber.*, 1923, 72; 1925, 72); seed—senfol (ether) 0.75-1.02% (*Apothekerztg, Berl.*, 1933, 612; *Chem. Zbl.*, 1934, I, 255); myrosin (*J. biol. Chem.*, 1932, 443; *Chem. Zbl.*, 1932, II, 2321). Sparingly cultivated in various parts of India.

BUCHANANIA (*Anacardiaceae*)

- B. LANZAN Spreng. syn. *B. latifolia* Roxb. H. & B.—*Chironji, Piyal*; Marathi & Gujarati—*Charoli*; Tam.—*Mudaima*; Tel.—*Sara*; S.—*Piyalaka*. Oil from kernels—used as subst. for almond oil in native medicinal preparations. Kernel—as ointment used in skin diseases. Gum—in diar. Bark contains 13.4% tannin (*Bull. imp. Inst., Lond.*, 1925,

1661; *J. Indian Chem. Soc.*, 1941, 557). Throughout India in dry deciduous forests; in N. W. India from the Sutlej to Nepal ascending to 3,000 ft.

BUTEA (*Leguminosae*)

* B. MONOSPERMA (Lam.) Kuntze syn. *B. frondosa* Koen. ex Roxb.

CAESALPINIA (*Leguminosae*)

C. CRISTA Linn. syn. *C. bonducella* Fleming. S.—*Kuberakshi*, *Putikaranja*; H.—*Karanju*, *Kat-karanja*; B.—*Nata*, *Nata-karanja*; Bo.—*Sagurghota*; Marathi—*Gajaga*; Tam.—*Kashichikay*; Tel.—*Gachacha-kaya*; Mal.—*Kazanchik-kuru*. Seeds—antipyr., antipyr., tonic, febrile, in asthma, in snake-bite. Tender leaves—in disorders of the liver. Leaves and seeds—used in external applications for dispersing inflammatory swellings. Leaves and bark—emmen., febrile, anthelm. Oil from seeds—emol., used as embrocation to remove freckles from the face and for stopping discharges from the ear. A bitter substance, bonducin (*J. Pharm. Chim.*, Paris, 1886, 115; *Ber. dtsh. Pharm. Ges.*, 1902, 143; *Indian J. med. Res.*, 1929, 377); seeds contain bitter substance phytosterinin, bonducin, saponin, fatty oil 20-24%, starch, sucrose, two phytosterols (*J. Indian Chem. Soc.*, 1930, 207); bitter amorphous glycoside bonducin isolated from the oil (*Proc. Acad. Sci. Unit. Prov.*, 1934, 141); bitter principle ineffective against bird malaria (*Indian Med. Gaz.*, 1943, 285). Throughout the hotter parts of India up to 2,500 ft. in the hills; common in Bengal and S. India.

CANNABIS (*Cannabinaceae*)

* C. SATIVA Linn. syn. *C. indica* Lam.

CAREYA (*Lecythidaceae*)

C. ARBOREA Roxb. S., H. & B.—*Kumbhi*; Tam.—*Ayma*; Tel.—*Araya*; Mal.—*Alam*. Bark and fruit—astrin., demulc. Flowers and juice of fresh bark—given with honey as demulc. in coughs and colds. Bark—used as antipyr., antipruritic in eruptive fevers, particularly in small-pox and in snake-bite. Root, bark and leaves—fish poison. Leaves contain 19% tannin (*Wealth of India*, II, 76). Sub-Himalayan tract from the Kangra district eastwards, Bengal, Central, Western and Southern India, up to 5,000 ft.

CARICA (*Caricaceae*)

C. PAPAYA Linn.

CARUM (*Umbelliferae*)

* C. CARVI Linn.

CASSIA (*Leguminosae*)

* C. ANGUSTIFOLIA Vahl.

C. OCCIDENTALIS Linn. H.—*Kasondi*; B.—*Kalkashunda*; S.—*Kasamarda*; Tam.—*Nattam-takarai*; Tel.—*Kasinda*; Mal.—*Natram-takara*. Plant—febrile, purg., diur., tonic. Leaves, roots and seeds—purg. Seeds and leaves—used externally in skin diseases, antipyr. Root—in snake-bite. Emodin, oxymethyl-anthraquinones, toxalbumin (*Apothekerztg. Berl.*, 1896, 537; *C.R. Soc. Biol.*, Paris, 1925, 862); seeds contain tannic acid, mucilage (36%), fatty oil (2.56%), emodin and a toxalbumin; chrysarobin isolated from the benzene extract of the seeds (*Chem. Abstr.*, 1944, 3033); fatty oil contents (Wehmer, Suppl., 42); oil constants (*Chem. Abstr.*, 1934, 2207).

C. TORA Linn. syn. *C. obtusifolia* Linn. S.—*Chakramarda*, *Dadamari*; H. & B.—*Chakunda*; Tam.—*Tagarai*; Tel.—*Tantemu*; Marathi—*Takla*. Decoct. of leaves—laxt. Leaves and seeds—in skin diseases, for ringworm and itch. Root—in snake-bite. Emodin, glucd. and a pleasant smelling fixed oil (5%) (*Pharm. J.*, 1889, 242; *Apothekerztg. Berl.*, 1896, 537; *J. Indian Chem. Soc.*, 1930, 521).* Throughout India as a weed.

CEDRELA (*Meliaceae*)

* C. TOONA Roxb.

CEDRUS (*Pinaceae*)

C. DEODARA (Roxb.) Loud. syn. *C. libani* Barrel. var. *deodara* Hook f.; *Pinus deodara* Roxb. S. & B.—*Devadaru*; H.—*Deodar*; P.—*Dewdar*, *Keli*; Tam.—*Tevadari*; Tel.—*Devadri*. Wood—diaphor., diur., carmin., useful in fever, flatulence, pulmonary and urinary dis-

orders, rheumatism, piles, gravels in kidney, antid. to snake-bite. Oil—diaphor., used in skin diseases and for ulcers. Bark—astrin., useful for fevers, diar. and dysen. Gum, cholesterin, essen. oil (*Ber. Schimmel u. Co., Lpz.* 1892, April, 41; 1909, Oct., 130; 1915, April 54; 1923, 49; *J. Chem. Soc.*, 1916, 791); wood yields oil with balsamic odour (*Indian For. Rec.*, 1922, 123); needles contain ascorbic acid (*Chem. Abstr.*, 1944, 2400); fresh needles contain 0.056% of ethereal oil (Wehmer, I, 42).^{*} North-western Himalayas from Kashmir to Garhwal at 4,000-10,000 ft.

CELASTRUS (*Celastraceae*)

* *C. PANICULATUS* Willd.

CEROPEGIA (*Asclepiadaceae*)

C. BULBOSA Roxb. H.—*Khapparkadu*; Bo.—*Patalatumbari*; P.—*Galot*; Tel.—*Palatige*. Tuberos roots—tonic, digest. Alk. ceropegine is the bitter principle of the root (Dymock, Warden & Hooper, II, 457). Punjab, Upper Gangetic Plain, Konkan, S. Kanara, Malabar, Deccan and Carnatic.

CINNAMOMUM (*Lauraceae*)

* *C. CAMPHORA* Nees & Eberm.

CISSAMPELOS (*Menispermaceae*)

* *C. PAREIRA* Linn.

CITRULLUS (*Cucurbitaceae*)

* *C. COLOCYNTHIS* Schrad.

CITRUS (*Rutaceae*)

C. MAXIMA (Burm.) Merr. syn. *C. decumana* Linn. B. & H.—*Chakotra, Mahanimbu*; S.—*Madhukarkati*; Tam.—*Pambalimasu*; Mal.—*Pamparamasam*; Tel.—*Pampalamasam*. Fruit—nutri., cardiotonic, refriger. Leaves—useful in epilepsy, chorea and convulsive cough. Naringin (*Proc. Indian Acad. Sci.*, 1942, 16A, 10); oil from peel—*d*-limonene, α -pinene, linalool, geraniol, etc. (Parry, 418, 426, 439, 442, 450, 451); composition of petitgrain oil (*Perfum. essent. Oil Rec.*, 1949, 333). Grown on a small scale in Coorg, Mysore, Bombay, Patiala, Punjab, Madras and Uttar Pradesh.

CLEMATIS (*Ranunculaceae*)

C. GOURIANA Roxb. Bo.—*Moriel*; Dehra Dun—*Belkangu*; Kan.—*Telcjadari*. Bruised leaves and stems—vesic., poisonous. Punjab Hills, W. Himalayas up to 5,000 ft., hilly districts throughout India between 1,000 and 3,000 ft.

C. TRILOBA Heyne ex Roth. S.—*Laghuparnika*; H.—*Murhari*; Bo.—*Moravela*. Plant—applied to boils and itch, used in leprosy, blood diseases, fevers and snake-bite. Acrid and poisonous properties due to anemonin (*J. Sci. Industr. Res.*, 1947, suppl., 8). Konkan, Deccan and W. Ghats.

CLEOME (*Capparidaceae*)

* *C. ICOSANDRA* Linn. syn. *C. viscosa* Linn.

CLERODENDRUM (*Verbenaceae*)

C. INDICUM (Linn.) Ktze. syn. *Clerodendron siphonanthus* (R. Br.) C.B. Clarke. S.—*Bhargi*; H. & Bo.—*Bharangi*; B.—*Bamunhati*; P.—*Arni*; Tel.—*Bharangi, Hunjika*; Tam.—*Narivalai*. Root—useful in asthma, cough and scrofulous affections. Resin—employed in syphilitic rheumatism. Juice of leaves—used with ghee as an application to herpetic eruptions and pemphigus. Leaves—vermifuge, bitter tonic. Alk. (*Bull. Inst. Bot. Buitenz.*, 1902, Nr. XIV. 35; *Meded. PItuin, Batavia*, 1900, 13); anthelm. property due to a bitter principle present in the leaves (Chopra, *Indigenous Drugs Enquiry*, 1941, 32). Deccan and Carnatic, W. coast districts of Madras State, Kumaon, from Sikkim and Assam to Tenasserim, and cultivated for ornamental purposes.

C. INERME (Linn.) Gaertn. S.—*Kundali*; H.—*Lanjai*; B.—*Bonjoi*; Bo.—*Vanajai*; Mal.—*Nirnochi*; Tam.—*Pinarichanganguppi*; Tel.—*Takkolakamu*. Juice of leaves—alter., febrg. Leaves—in form of poultice used to resolve buboes. Juice of root—alter. Root—by boiling in oil a liniment obtained which is useful in rheumatism. Medicinal properties of the plant resemble those of *Swertia chirata*. Leaves contain amorphous

bitter principle, resin, gum (Dymock, Warden & Hooper, III, 76). Throughout India near the sea.

- C. PHLOMIDIS Linn. f. S.—*Vataghni*; H. & Marathi—*Arni*; Bo.—*Airan*; Tam.—*Taludalai*; Tel.—*Takkolamu*; Mal.—*Tirutali*. Root—bitter tonic, given in convalescence of measles. Juice of leaves—alter., given in neglected syphilitic complaints. Plant—given to cattle as a cure for diar. and worms. Throughout India in the drier parts and Baluchistan.

✱ CLITORIA (*Leguminosae*)

- C. TERNATEA Linn. S.—*Aparajita*; H. & B.—*Aparajit*; M.—*Kakkanan*. Seeds—purg., aper. Root—bitter, cath., purg., diur. Root bark—diur., laxt. Plant—used in snake poisons. Seeds contain a fixed oil and a bitter resinous principle; both seeds and root-bark contain tannin (Dymock, Warden & Hooper, I, 460). A common garden plant; also occurs among hedges all over the tropical region from the Himalayas to Ceylon.

COCCULUS (*Menispermaceae*)

- C. HIRSUTUS (Linn.) Diels. B.—*Huyer*; Bo.—*Vasanvel*; H.—*Jamti-ki-bel*; S.—*Garudi*; Tam.—*Kattukkodi*; Tel.—*Dusaraitige*. Root—refrig., laxt., sudorific, alter., useful in chr. rheumatism and venereal diseases. Juice of leaves—when mixed with water forms a jelly which is taken as a cooling medicine for gonorr. and used externally for eczema, prurigo and impetigo. Tropical and subtropical India from the foot of the Himalayas to S. India.

COLEUS (*Labiatae*)

- C. AMBOINICUS Lour. syn. *C. aromaticus* Benth. B.—*Paterchur*; Bo. & H.—*Pathorchur*; S.—*Pashanabhedi*; Tam.—*Karpuravalli*. Leaves—in urinary diseases, vaginal discharges. Juice of leaves—mixed with sugar acts as a powerful arom. carmin., given in colic and dyspep. Essen. oil containing carvacrol present in the herb in small quantities (*Ber. Schimmel u. Co., Lps.*, 1919, 15; 1922, 19; *Pharm. Weekbl.*, 1915, 253; Parry, I, 269). Cultivated in gardens throughout India. Wild in Rajasthan.

COMMIPHORA (*Burseraceae*)

- * C. MUKUL (Hook. ex Stocks) Engl. syn. *Balsamodendron mukul* Hook. ex Stocks.
C. MYRRHA (Nees) Engl. syn. *Balsamodendron myrrha* T. Nees. S.—*Rasagandh*; H.—*Boli*. B.—*Gandharash*; M.—*Vellaippolam*. Gum resin—in dyspep., chlorosis, amenorr. and uterine affections. Essen. oil, bitter substance (*Analyst*, 1909, 519; *Arch. Pharm., Berl.*, 1905, 641; 1906, 412; 1907, 427). A native of Arabia and of the African coast of the Red Sea.
C. ROXBURGHII (Arn.) Engl. syn. *Balsamodendron roxburghii* Arn. B.—*Gugala*; Bo.—*Gugal*; S. & Tel.—*Agaru*; Tam.—*Kungulu*. Gum resin—used in the same way as from *C. mukul*. Assam, Sylhet, E. Bengal and Madhya Pradesh.

CONVOLVULUS (*Convolvulaceae*)

- C. ARVENSIS Linn. H.—*Hiranpadi*; Bo.—*Hiranpag*; B.—*Gondal*; S.—*Bhadrabala*; P.—*Hiranpaddi*. Root—purg. Convolvulin (Dymock, Warden & Hooper, II, 543); no alk. detected (*Trudy Uzbekskogo Gosudarst. Univ., Sbornik Rabot Khim.*, 1939, 43; *Chem. Abstr.*, 1941, 4029); plant yields 1.52-4.0% resinous substance possessing cath. properties; dried rhizome contains 4.9% resin (*Riv. Ital. Essenze*, 1946, 105; *Chem. Abstr.*, 1947, 2859). A common weed of cultivation all over India, ascending to 10,000 ft. in the Himalayas.

CORCHORUS (*Tiliaceae*)

- C. AESTUANS Linn. syn. *C. acutangulus*. Lam. B.—*Tilapat*. Seeds—stomch., in pneumonia. Analysis of leaves (*Indian J. Med. Res.*, 1949, 29). Throughout the hotter parts of India.
C. CAPSULARIS Linn. Assam.—*Titamara*; S.—*Kalasaka*; H. & B.—*Narcha*, *Titapat*. Infusion of leaves—demulc., stomch., laxt., carmin., stim. to increase appetite, bitter tonic, in dysen., fever, dyspep. liver disorders. Decoct. of root and unripe fruit—in diar. Leaves contain glucd. capsularin, which appears to be related to corchorin (*J. Chem. Soc.*, 1922, 1044; *Merck's Index*, 1929, 383; *J. Indian Chem. Soc.*, 1927, 205; 1928, 759;

1930, 905); corchorin and bitter substance corchoritin isolated from seeds (*J. Indian Chem. Soc.*, 1930, 83, 905; 1931, 651); cardiac aglycon corchorotoxin having heart action similar to digitalis group of genins but not as intense obtained from seeds (*Helv. Chim. Acta*, 1949, 2385; *Chem. Abstr.*, 1950, 4015). Throughout the hotter parts of India. Cultivated in most tropical countries.

- C. *DEPRESSUS* (Linn.) Christensen. H.—*Baphuli*; Gujarati—*Bahuphali*; P.—*Babuna*; S.—*Bhedani*. Leaves—emol. Plant—has tonic properties, given as a cooling medicine in fevers. Seeds—in decoct. with milk and sugar given as tonic. Mucilage—used in gonorrhea. Punjab, Sind, Baluchistan, Cutch, Gujarat and Deccan.

CORIANDRUM (*Umbelliferae*)

- * C. *SATIVUM* Linn.

CRATAEVA (*Cappariaceae*)

- C. *NURVALA* Buch.-Ham. S.—*Varuna*; H. & B.—*Barun*; P.—*Barna*; Bo.—*Vayavarna*; Tam.—*Maralingam*; Tel.—*Magalingam*. Bark—demulc., stomachic, laxative, diuretic, antipyretic, alterative, tonic, useful in calculus affections, disorders of urinary organs and used in snake-bite. Fresh leaves and root bark—rubefacient. Bark contains saponin and tannin (Wehmer, I, 392; *J. Bombay Nat. Hist. Soc.*, 1939, 130). Almost all over India wild or cultivated. Often found along streams, but also in dry, deep boulder formations in the sub-Himalayan tract.

CROCUS (*Iridaceae*)

- * C. *SATIVUS* Linn.

CROTALARIA (*Leguminosae*)

- C. *JUNCEA* Linn. S.—*Sana*; H.—*Sunn*; B.—*Shonpat*, *Ghore sun*; Bo.—*Santag*; Tam.—*Sannappu*; Tel.—*Jamumu*; Mal.—*Wuckoo nar*. Seeds—used to purify blood, in impetigo, psoriasis, emmenagogue, poisonous to livestock (*Bull. Imp. Inst., Lond.*, 1921, 452; *Fmr's Bull. U.S. Dep. Agric.*, No. 1980). Cultivated throughout India from the base of the Himalayas to Ceylon.

CROTON (*Euphorbiaceae*)

- C. *TIGLIUM* Linn. S.—*Jayapala*; H. & Bo.—*Jamalgota*; B.—*Jaypal*; Tam. & Mal.—*Nervallam*; Tel.—*Nepala*. Seeds and oil—drastic purgative, irritant, rubefacient, cathartic, fish poison, in snake-bite. Wood—diaphoretic in small doses and purgative and emetic in large doses. (*J. Pharm. Chim., Paris*, 1898, 524; *J. Chem. Soc.*, 1864, 195; *Pharm. J.*, 1905, 479; *Arch. Exp. Path. Pharmacol.*, 1915, 138; 1930, 115); seed kernels contain 55-57% croton oil; the poison occurs to the extent of 2-3% in the fatty acids (*Helv. Chim. Acta*, 1942, 569; *Chem. Abstr.*, 1942, 6500); the oil amounts to 30-45% of the whole seed or 43-63% of the kernel (Wealth of India, II, 383); purgative effect may also follow the application of oil to the skin; oil contains a toxic resin; in addition to the vesicant and purgative principles which pass into the oil, the seed kernels contain 2 toxic proteins, croton globulin and croton albumin, sucrose and a glycoside, crotonoside (Thorpe, III, 434). Naturalized and cultivated in Bengal, Assam, South India. Also cultivated in gardens in other parts of India.

CUCUMIS (*Cucurbitaceae*)

- C. *MELO* Linn. var. *UTILISSIMUS* Duthie & Fuller syn. *C. utilisissimus* Roxb. B.—*Kakur*; Bo.—*Kakadi*; H.—*Kakri*; S.—*Bahukanda*. Seeds—cooling, nutritive, diuretic, used in painful micturition and suppression of urine (*Ann. Bot., Lond.*, 1892, 195). Cultivated in many parts of India, specially in upper India and particularly in Uttar Pradesh and Punjab.
- C. *SATIVUS* Linn. S.—*Sukasa*; H. & B.—*Khira*; Bo.—*Kakri*, *Kankri*; Tam.—*Vellarikkai*; Tel.—*Dosakaya*. Fruit—nutritive, demulcent. Seeds—cooling, tonic, diuretic. Fruits contain an enzyme erepsin (*C. R. Acad. Sci., Paris*, 1905, 320; *Biochem. Z.*, 1929, 109; *Ber. Dtsch. Bot. Ges.*, 1928, 582); analysis of fruit, vitamin B₁ and C (*Hlth. Bull.*, No. 23, 1941, 32); proteolytic enzymes, ascorbic acid oxidase, succinic and malic dehydrogenases present in fruit (*Indian J. Med. Res.*, 1933, 17; *Curr. Sci.*, 1936-37, 296; *J. Indian Chem.*

Soc., 1943, 277); odorous principle is extractable with alcohol (*J. Sci. Industr. Res.*, 1950, suppl., 242). Cultivated in all parts of India.

CUCURBITA (*Cucurbitaceae*)

C. MAXIMA Duch. H.—*Mihakaddu*, *Sitaphal*; B.—*Saphuri komra*; Bo.—*Lal bhopali*; Tam.—*Parangikayi*; Tel.—*Gummadi*; Mal.—*Mathan*. Seeds—anthelm., used as taenicide, diur. and tonic. Oil—nerve tonic. Fruit pulp—used as poultice, applied to burns, inflam. and boils. Saponin (*Kew Bull.*, 1909, 397; *J. Amer. Chem. Soc.*, 1896, 600); curcubitin, lutein (*Bull. Chem. Soc. Japan*, 1931, 221; *Ber. Dtsch. Chem. Ges.*, 1934, 824); analysis of fruit (*Hlth. Bull.*, No. 23, 1941, 33). Cultivated throughout India.

CUMINUM (*Umbelliferae*)

* C. CYMINUM Linn.

CURCULIGO (*Amaryllidaceae*)

C. ORCHIOIDES Gaertn. S.—*Talamulika*; H. & Bo.—*Kalimusli*; B.—*Talamuli*; Tel.—*Nelatatygadda*; Tam.—*Nilappancik-kilhangu*. Rhizome—prescribed in piles, jaundice, asthma, diar., gonorr., considered demulc., diur., tonic, aphrodis., used as poultice for itch and skin diseases. Sub-tropical Himalayas from Kumaon eastwards and in the Western Ghats from Konkan southwards.

CURCUMA (*Zingiberaceae*)

C. AMADA Roxb. S.—*Karpura-haridra*; H.—*Anhaldi*; B.—*Amada*; Gujarati—*Ambahaldara*; Tam.—*Mangai inji*; Tel.—*Mamidiallam*. Rhizome—carmin., stomch., cooling, applied over contusions and sprains. Rhizomes yield 1.1% essen. oil containing d- α -pinene 18%, ocimene 47.2%, linalool 11.2%, linalyl acetate 9.1%, safrole 9.3% (*Indian Soap J.*, 1941, 200; *Chem. Abstr.*, 1941, 6393). Wild in parts of Bengal, Konkan and Madras.

C. AROMATICA Salisb. S.—*Vana-haridra*; H.—*Jangli haldi*; B.—*Banhalud*; Bo.—*Ran hald*; Tam.—*Kasturi-manjal*; Tel.—*Kasturi-manjal*. Rhizome—tonic, carmin., externally applied in combination with astringents, bitters and aromatics to bruises and sprains, to promote eruptions, in snake-bite. Rhizomes yield 6.1% essen. oil (*J. Chem. Soc.*, 1928, 2496; *J. Indian Inst. Sci.*, 1926, 140A); colouring matter curcumin (*J. Soc. Chem. Ind., Lond.*, 1928, 54T). Wild throughout India, and cultivated in Bengal and Travancore.

* C. LONGA Linn. = C. DOMESTICA Valetou.

* C. ZEDOARIA Rosc.

CUSCUTA (*Convolvulaceae*)

C. REFLEXA Roxb. S.—*Amaravela*; H.—*Akasbel*; B.—*Algusi*; Marathi—*Nirmuli*; P.—*Amil*, *Nilathari*; Tel.—*Sitamma pogu nalu*. Seeds—carmin., anthelm., alter. Plant—purg., used externally against itch, internally in protracted fevers. Infusion of plant—used as a wash for sores. Stems—useful in bilious disorders. Plant contains cuscutalin and cuscutin; cuscutalin pharmacologically potent drug; seeds contain pigments amarbelin and cuscutin and a wax and yield a semi-drying oil (*J. Indian Chem. Soc.*, 1935, 384, 587; *Chem. Abstr.*, 1936, 459; *J. Indian Chem. Soc.*, 1936, 264, 531; *Chem. Abstr.*, 1936, 6327; *Proc. Nat. Acad. Sci. India*, vol. 10, 1940, 68). A parasitic climber common throughout the plains of India, ascending the hills up to 8,000 ft.

CYMBOPOGON (*Gramineae*)

C. CITRATUS (DC.) Stapf syn. *Andropogon citratus* DC. B.—*Gandhabena*; H.—*Gandhatrina*; P.—*Khawi*; S.—*Bhustrina*; Tam.—*Vasanappillu*; Tel.—*Nimmagaddi*; Mal.—*Vasanappillu*. Infusion of leaves—sudorific, stim., antiper., in catarrh. Oil—carmin., in cholera. Essen. oil (*Pharm. J.*, 1923, 660; *Ber. Schimmel u. Co., Lpz.*, 1915, Oct., 35; 1922, 43; *Perfum. Essent. Oil Rec.*, 1926, 88); citral is the principal constituent of the essen. oil, the percentage of citral varying with locality (Parry, I, 73); essen. oil content varies with the age of the grass; optimum age 18-24 months giving oil with citral content 71-75.5% (*Parfum. Mod.*, 1937, 35; *Chem. Abstr.*, 1937, 2749); fresh lemon grass contains 0.26-0.52% essen. oil containing 78-85.5% citral (*Rep. P. R. agric. Exp. Sta.*, 1940, 29; *Chem. Abstr.*, 1942, 5614); dry material yields 0.4% essen. oil

containing 72.3% citral (*Rev. Fac. Cienc. quim. La Plata*, 1946, 7; *Chem. Abstr.*, 1947, 2210). Grown in gardens in the Punjab, Bombay and Baroda. Reported to grow wild in Mysore.

- C. *NARDUS* (Linn.) Rendle syn. *Andropogon nardus* Linn. B.—*Kamakher*; H.—*Ganjni*; S.—*Guchcha*; Tam.—*Kamachipillu*; Tel.—*Kamkshikasuru*; Mal.—*Kamakshi-pillu*. Infusion of leaves—stomch., carmin. Oil—stim., carmin., antisp., diaphor., sudorific, rubft. Essen. oil (*Bull. Imp. Inst., Lond.*, 1910, 144; *Ber. Schimmel u. Co., Lpz.*, 1913, 19; *Chem. & Drugg.*, 1919, 815); Ceylon citronella grass yields 0.4% essen. oil containing geraniol 57.6-61.1%, citronellal 7.7-14.2% (*Soap Sanit. Chem.*, 1940, No. 9, 30; No. 10, 32; *Chem. Abstr.*, 1941, 6387); Java citronella grass yields an oil much superior (total geraniol not less than 85% including not less than 35% citronellal) to that of Ceylon citronellal (*Soap Sanit. Chem.*, 1942, No. 2, 24; No. 3, 25; *Chem. Abstr.*, 1943, 1832). Throughout the hotter parts of India wild or cultivated.

- C. *SCHOENANTHUS* (Linn.) Spreng. syn. *Andropogon schoenanthus* Linn. B.—*Gandhabena*; Bo.—*Rohisha*; H.—*Rousaghas*; S.—*Bhutika*; M.—*Shakanarupillu*. Plant—arom., stim. Decoct. of grass—febge. Oil—applied in rheumatism and neuralgia. Essen. oil (*Ber. Schimmel u. Co. Lpz.*, 1911, April, 19; Oct., 17; *J. Chem. Soc.*, 1922, 144; 1923, 2267). Hotter parts of India, wild or cultivated, from the Punjab to Burma and southwards to Travancore.

CYNODON (*Graminae*).

- C. *DACTYLON* (Linn.) Pers. B.—*Dubh, Durba*; H.—*Dhub, Hariali*; S.—*Dhurva, Haritali*; Marathi—*Haryali*; Tel.—*Harvali*; Tam.—*Arugampullu*. Decoct. of root—diur., in dropsy, in secondary syphilis. Infusion of root—for stopping bleeding from piles. Crushed roots—mixed with curds used in chr. gleet. Juice of plant—astrin., used as application to fresh cuts and wounds, diur., used in dropsy and anasarca, in hysteria, epilepsy, insanity, astrin. in chr. diar. and dysen.; useful in catar. ophthalmia. Analysis of grass (*Misc. Bull. Imp. Coun. Agric. Res. India*, No. 25, 1946, appx. I, III). Throughout India ascending to 8,000 ft. in the Himalayas.

DAEMIA (*Asclepiadaceae*).

- * D. *EXTENSA* R. Br.; see *PERGULARIA EXTENSA* N.E. Br.

DALBERGIA (*Leguminosae*)

- D. *LATIFOLIA* Roxb. S.—*Shishapa*; B.—*Sitsal*; Tel.—*Cittegi*; Tam.—*Itti, Todagatti*. Plant—bitter tonic, stomch., used in dyspep., diar., leprosy, obesity and worms. Bark contains tannin (*Indian For. Leaflet*, No. 72, 1949, 23). Oudh, E. Bengal, Bihar, Sikkim, Bundelkhand, Madhya Bharat and West Peninsula.

- D. *SISSOO* Roxb. S.—*Shingshupa*; H. & B.—*Sisu*; Bo. & Tam.—*Sisu*; Tel.—*Sinsupa*. Leaves—bitter, stim. Decoct. of leaves—useful in gonorr. Roots—astrin. Wood—alter., useful in leprosy, boils, eruptions and to allay vomiting. Pods contain 2% tannin (*Indian For. Leaflet*, No. 72, 1949, 9). Baluchistan, Waziristan, W. Himalayas up to 4,000 ft., Terai of Nepal and Sikkim to Upper Assam; extensively planted throughout India.

DATURA (*Solanaceae*)

- * D. *ALBA* Nees; see D. *METEL* Linn.

DAUCUS (*Umbelliferae*)

- D. *CAROTA* Linn. var. *SATIVA* DC. (cultivated carrot). S.—*Shikha-mulam*; H., B. & P.—*Gajar*; M.—*Gajjara kelangu*. Seeds—arom., stim., carmin., useful in diseases of the kidney and in dropsy, nervine tonic, aphrodis., given in uterine pain. Roots—refrig. Pyrrolidine and daucine (*Bull. Soc. Chim., Paris*, 1907, 1001); As 0.005 mg. in 100 g. roots (*C.R. Acad. Sci., Paris*, 1912, 893; *Chem. Zbl.*, 1912, I, 1730); α -, β - and γ -carotene (*J. Amer. Chem. Soc.* 1933, 4728); 1.65% essen. oil containing carrotal (*Parfums de Fr.*, 1936, 127; *Chem. Abstr.*, 1936, 5726); analysis of edible portion (*Hlth. Bull.*, No. 23, 1941, 31; *Nature, Lond.*, 1941, 132). Cultivated throughout India.

DELPHINIUM (*Ranunculaceae*)

- D. *DENUDATUM* Wall. H.—*Nirbisi*; P.—*Judwar*; S.—*Nirvisha*. Roots—bitter, stim., alter.,

tonic, in toothache, adulterant for aconite. W. temperate Himalayas from Kashmir to Kumaon, 8,000-12,000 ft.

DENDROCALAMUS (*Gramineae*)

D. STRICTUS (Roxb.) Nees. H.—*Bāns kaban*; B.—*Karail*; Bo.—*Bas*; S.—*Vansha*; Tel.—*Sadanapa veduru*; Tam.—*Kalmungil*. Silicious matter—tonic astrin. Leaves—ecbolic to animals. In deciduous forests and in dry or moderately dry regions practically all over India up to 3,500 ft.

DESMOSTACHYA (*Gramineae*)

D. BIPINNATA Stapf. S. & B.—*Darbha, Kusha*; H.—*Dab, Durva*; Bo.—*Darbh*; Tel.—*Darbha*. Culms—diur., stim., in dysen., menor. Throughout India in hot and dry places.

DESMOTRICHUM (*Orchidaceae*)

D. FIMBRIATUM Bl. syn. *Dendrobium macraei* Lindl. B.—*Jibanti*; Bo., H. & S.—*Jivanti*. Plant—stim., demulc., tonic, used in snake-bite. Alk. (*Bull. Inst. Bot. Buitenz.*, 1902, 36); traces of alk. jibantine and two acids (*J. Bombay Nat. Hist. Soc.*, 1936, 794; Dymock, Warden & Hooper, III, 391). W. Ghats of Bombay and Madras States, Sikkim and Khasia Hills.

DICHROSTACHYS (*Leguminosae*)

D. CINEREA W. & A. S.—*Viravriksha*; H.—*Vurtuli*; Bo.—*Segumkati*; Tam.—*Vidattalai*; Tel.—*Veltura*. Bruised young shoots—useful in ophthalmia. Root—astrin., used in rheumatism, urinary calculi and renal troubles. N.W. India, Madhya Bharat, Rajasthan, Deccan, S. Mahratta Country and N. Kanara to Ceylon.

DIGITALIS (*Scrophulariaceae*)

* *D. PURPUREA* Linn.

DIOSPYROS (*Ebenaceae*)

D. PEREGRINA Gurke syn. *D. embryopteris* Pers.; *D. malabarica* Desr. S.—*Tinduka*; H. & B.—*Gab*; Bo.—*Tendu*; Tam.—*Kattatti, Tumbi*; Tel.—*Tinduki*; Mal.—*Panachi*. Fruit and stem bark—astrin. Oil of seeds—given in diar. and dysen. Unripe fruit—acid, bitter, oleaginous. Infusion of fruits—used as gargle in aphthae and sore throats; juice used as application for wounds and ulcers. Bark—used in dysen. and intermittent fevers. Fruit 15 and bark 12% tannin. Ether extract of the fruits possesses anti-bacterial activity (*Indian For. Leaflet*, No. 72, 1949, 10; *J. Sci. Industr. Res.*, 1952, 261B). Practically throughout India.

DOLICHOS (*Leguminosae*)

D. BIFLORUS Linn. S.—*Kulaththa*; H. & Bo.—*Kulthi, Koolthee*; B.—*Kurti-kalai*; Tam.—*Kollu*; Tel.—*Ulavalu*; Mal.—*Muthiva*. Seeds—astrin., diur., tonic. Decoct.—used in leucor. and menstrual disorders. Seeds rich source of urease (*Biochem. J.*, 1914, 449; *J. Biol. Chem.*, 1916, 297; *Indian J. Med. Res.*, 1932, 1077; *Ilth. Bull.*, No. 23, 1951, 30; *J. Indian Inst. Sci.* 1930, 153A; *Proc. Indian Acad. Sci.*, vol. 27B, 1948, 26; *Curr. Sci.*, 1946, 15).* Himalayas to Ceylon, ascending to 3,000 ft., in Sikkim; sometimes cultivated.

ECHINOPS (*Compositae*)

E. ECHINATUS Roxb. H.—*Utakanta, Gokru*; Marathi—*Utanti*; S.—*Kantalalu, Utati*. Plant—alter., diur., nerve tonic, used in hoarse cough, hysteria, dyspep., scrofula and ophthalmia. Powdered roots—applied to wounds in cattle to destroy maggots; mixed with acacia gum, applied to the hair to destroy lice. More or less throughout India, ascending to 5,000 ft. in the hills.

ECLIPTA (*Compositae*)

E. ALBA Hassk. S.—*Bhiringaraja, Kesaraja*; H.—*Bhangra*; B.—*Kesuti, Kesuria*; Marathi—*Maka*; Tam.—*Garuga*; Tel.—*Galagara*. Plant—tonic and deobstruent in hepatic and spleen enlargements, emetic. Plant juice—in combination with aromatics administered for catar. jaundice. Leaves—in scorpion-sting. Leaf juice—along with honey used as remedy for catarrh in infants. Root—emetic, purg., applied externally as antisept.

ulcers and wounds in cattle. Alk. ecliptine (Dymock, Warden & Hooper, II, 268); alk. nicotine 0.078% (*J. Indian. Chem. Soc.*, 1943, 181; *Chem. Abstr.*, 1944, 1609). Common weed in moist situations throughout India, ascending up to 6,000 ft. on the hills.

ELEPHANTOPUS (*Compositae*)

E. SCABER Linn. S.—*Gojihva*; H.—*Gobhi*; B.—*Gojialata*; Bo.—*Hastipata*; Tam. & Mal.—*Anashovadi*. Plant—astrin., cardiac tonic, alter., febrile, in snake-bite. Decoct. of roots and leaves—emol., given in dysuria, diar., dysen. and swellings or pains in stomach. Root—given to arrest vomiting; powdered with pepper applied to toothache. Bruised leaves—boiled in coconut oil applied to ulcers and eczema. Alcoholic extract of whole shoot shows antibiotic activity (*Indian J. Med. Res.*, 1949, 169). Throughout the hotter parts of India.

ELETTARIA (*Zingiberaceae*)

* E. CARDAMOMUM Maton.

EMBELIA (*Myrsinaceae*)

E. RIBES Burm. f. S.—*Vidanga*; P.—*Babrun*; H.—*Baberang*; B.—*Biranga*; Bo.—*Vaivara*; *Vavadinga*; Tam. Tel. & Kan.—*Vayuvilanga*. Dried fruit—anthelm., astrin., alter., tonic, in scorpion-sting and snake-bite. Decoct. of dried fruits—used for fevers and diseases of chest and skin. Infusion of roots—given for coughs and diar. Embelic acid (*Arch. Pharm., Berl.*, 1900, 15; *Apothekerztg. Berl.*, 1913, 699); drug contains embelin 2.5-3.1, quercitol 1.0, and fatty ingredients 5.2%; an alk., chirstembine, a resinoid, and volatile oil (U.S.D., 1441; *Indian For. Bull., N.S.*, No. 102, 1941; *J. Amer. Chem. Soc.*, 1948, 71; *J. Indian Chem. Soc.*, 1929, 577); drug has no effect on hookworm and tapeworm but effective in the treatment of ascariasis (*Indian Med. Gaz.*, 1947, 66); aqueous extracts of fruit show anti-bacterial activity against *Staphylococcus aureus* and *Escherichia coli* (*Indian J. Med. Res.*, 1949, 169). Throughout India up to 5,000 ft.

EMBLICA (*Euphorbiaceae*)

E. OFFICINALIS Gaertn. syn. *Phyllanthus emblica* Linn. B.—*Amla*, *Amlaki*; H.—*Amla*, *Aonla*; Kan.—*Amalaka*; Mal.—*Nelli*; S.—*Adiphala*, *Amalaka*; Tam.—*Nelli*; Tel.—*Amalakamu*. Fruit—acrid, cooling, refriger., diur., laxt. Raw fruit—aper. Dried fruit—useful in haemor., diar., and dysen.; in combination with iron used for anaemia, jaundice and dyspep. Fermented liquor prepared from the fruit—used in jaundice, dyspep. and cough. *Sherbet* of amla with lemon juice—taken for arresting acute bacillary dysen. Exudation from incisions on the fruit—used as external application for the inflam. of the eye. Flowers—cooling, refriger., aper. Root and bark—astrin. Seeds—used for asthma, broncht. and biliousness. Fruit rich natural source of vitamin C; fruit successfully used in the treatment of human scurvy (Minor Forest Products, Mysore, 1945, 55; *Biochem. J.*, 1936, 1014; *Indian J. med. Res.*, 1939, 429; *Ann. Biochem.*, 1942, 205; 1941, 307; *Nature, Lond.*, 1944, 684); seeds contain fixed oil, phosphatides and essen. oil (*J. sci. industr. Res.*, 1951, 88B; *Annu. Progr. Rep., Cen. Drug Res. Inst., Lucknow*, 1951-52); fruits, bark and leaves rich in tannin (*Indian For. Leaflet*, No. 72, 1944, 9; *Biochem. J.*, 1936, 1014; *Chem. Abstr.*, 1931, 230; Burkill, I, 921)*. Common in the mixed deciduous forests of India ascending to 4,500 ft. on the hills. Often cultivated in gardens and homeyards.

EULOPHIA (*Orchidaceae*)

E. CAMPESTRIS Wall. B.—*Salibmisri*, *Sung-misrie*; P. & H.—*Salibmisri*; Bo.—*Salum*; S.—*Amrita*, *Pranada*. Rhizome—esteemed as tonic and aphrodis., used in stomatitis, purulent cough and heart troubles. Throughout the greater part of India, mostly in the plains.

E. NUDA Lindl. S.—*Manya*; H.—*Goruma*; B.—*Budbar*; Bo.—*Mankand*. Tubers—used for tumours, scrofulous glands of the neck, broncht. and diseases of blood and as vermi-

fuge. Tropical Himalayas from Nepal eastwards to Assam, and in the Deccan from Konkan southwards.

EUPHORBIA (*Euphorbiaceae*)

E. *ACAULIS* Roxb. Juice—acrid, vesic. Tropical Himalayas, Kumaon, Nepal, Oudh, Bengal and Konkan.

E. *ANTIQUORUM* Linn. S.—*Vajrakantaka*; H.—*Tridhara-sehund*; B.—*Tikta sij*; Bo.—*Naraseja*; Marathi—*Narasya*; Tam.—*Vachirom*; Tel.—*Bomajemudu*; Mal.—*Chadurakalli*. Plant—purg., digest., pungent. Root-bark—purg. Decoct. of stem—in gout. Juice of plant—purg., irrit. in rheumatism and toothache, used in nervine diseases, dropsy, palsy, deafness, to kill maggots in wound, and application for warts and other cutaneous affections. Euphorbin (*Arch. Pharm., Berl.*, 1886, 729); saline extract of the stem shows antibiotic activity (*J. Sci. Industr. Res.*, 1952, 261B). Throughout the hotter parts of India, in dry places ascending to 2,000 ft. on hills.

E. *HIRTA* Linn. syn. *E. pilulifera* auct. non Linn. B.—*Baro-kheruic*; Bo.—*Nayeti*; H.—*Dudhi*; S.—*Pusitoo*, Tam.—*Amampatchairisi*, *Patchaiyarissi*; Mal.—*Nelapalai*. Plant—used in diseases of children in worms, bowel complaints, cough. Juice of plant—in dysen., and colic. Decoct. of plant—in bronchial affections and asthma. Latex of plant—used as application for warts (*Indian J. Med. Res.*, 1949, 29). Alk., essen. oil (*Pharm. J.*, 1909, 141; 1913, 506; 1923, 162); appears to contain two active principles one of which causes a spike phase in guinea-pig ileum, and the other a relaxing action on smooth muscle (*J. Amer. Pharm. Ass.*, 1948, 491; *Chem. Abstr.*, 1949, 855); l-inositol isolated (*J. Am. Pharm. Assoc.*, 1951, 474; *Chem. Abstr.*, 1951, 10507). Throughout the hotter parts of India.

E. *NERIIFOLIA* Linn. S.—*Snuhi*; H.—*Schund*; B.—*Mansasij*; Bo.—*Minguta*; Tam.—*Ilalkalli*; Tel.—*Akujemudu*; P.—*Gangichu*. Milky juice—used as purg., and rubft. expect., to remove warts and cutaneous eruptions. Root—in scorpion-sting and snake-bite, antisp., fish poison. Orissa and Deccan. Cultivated elsewhere in India.

E. *THYMIFOLIA* Linn. S.—*Laghududhika*, *Racta-vinda-chada*; H.—*Choti dudhi*; B.—*Dudiya*, *Shwethkeruee*; Bo.—*Nayeti*; Tam.—*Sitrapaladi*; Tel.—*Reddivari manubala*. Dried leaves and seeds—arom., astrin., stim., laxt., given to children in bowel complaints. Juice of plant—for ringworm, in snake-bite and skin diseases. Root—used for amenor. Essen. oil (*Perfum. Essent. Oil Rec.*, 1935, 219); leaves and stems contain 5, 7, 4-trihydroxy flavone-7-glycoside (*J. Agric. Chem. Soc., Japan*, 1941, 483; *Chem. Abstr.*, 1942, 3625; 1935, 7016). Throughout India in the plains and lower hills; ascending up to 5,500 ft. in Kashmir.

E. *TIRUCALLI* Linn. H.—*Konpal*, *Schund*; B.—*Lankasij*; Tam.—*Tirukalli*, *Kalli*; Tel.—*Chemuuu*. Milky juice—vesic., rubft., purg., counter-irrit., application for warts, rheumatism, neuralgia, toothache, in cough, asthma and ear-ache, fish poison. Euphorbon (*Arch. Pharm., Berl.*, 1886, 729; *Ann. Chim. Appl., Roma*, 1928, 540); from fresh latex isoeuphorol isolated, dried latex contains a ketone euphorone (*J. Sci. Industr. Res.*, 1949, 234B; *J. Chem. Soc.*, 1949, 2554; 1950, 1562). Naturalized in the drier parts of Bengal, Deccan, S. India; elsewhere largely cultivated for hedges. A native of Africa.

EVOLVULUS (*Convolvulaceae*)

E. *ALSINOIDES* Linn. S.—*Vishnugandhi*; H.—*Sankhapushpi*; Bo.—*Shankha valli*; Tam.—*Visnukarandi*; Tel.—*Vishnukaranta*; Mal.—*Vistnaclandi*. Plant—bitter, tonic, fehg., vermifuge, in dysen. Leaves—made into cigarettes smoked in chr. broncht. and asthma. Alk. (Chopra, 489). Common weed in open and grassy places almost throughout India, ascending to 6,000 ft. in the Himalayas.

FAGONIA (*Zygophyllaceae*)

F. *ARABICA* Linn., see F. *CRETICA* Linn.

F. *BRUGUIERI* DC., see F. *CRETICA* Linn.

F. *CRETICA* Linn. H.—*Damahan*; Marathi—*Dhamasa*; P.—*Dama*; S.—*Dusparsha*; Tel.—

Chittigara. Plant—bitter, astrin., tonic, febrile, prophylactic against small pox, in dropsy, delirium and any disorder which arises from poisoning. Leaves and twigs—cooling. Deccan, W. Khandesh, Cutch, Sind, Baluchistan, Waziristan, W. Rajasthan, Upper Gangetic Plain, Punjab, and westwards to Afghanistan.

FERONIA (*Rutaceae*)

F. ELEPHANTUM Correa; see F. LIMONIA (Linn.) Swingle.

F. LIMONIA (Linn.) Swingle syn. *F. elephantum* Correa. S.—*Kapittha*; H.—*Kavitha*; B.—*Kathbel*; Bo.—*Kavit*; Tam.—*Narivila*; Tel.—*Velaga*. Fruit—astrin., stomch., stim. Leaves—arom., carmin. Pulp—applied externally as a remedy for bites of venomous insects and reptiles. Bark—prescribed for biliousness. Leaves yield 0.73% essen. oil (*J. Indian Chem. Soc.*, 1949, 342; *Chem. Abstr.*, 1950, 2706; *J. Pharm. Lond.*, 1905, 289). Indigenous in S. India. Cultivated in many parts of India.

FERULA (*Umbelliferae*)

* F. FOETIDA Regel.

* F. NARTEX Boiss.

FICUS (*Moraceae*)

F. BENGALENSIS Linn. S.—*Vata*; H.—*Bor*; B.—*Bar*; Bo.—*Vad*; Marathi—*Vada*; P.—*Bor*; Tam.—*Pudavam*; Tel.—*Peddamatti*. Milky juice—applied externally in rheumatism and lumbago. Infusion of bark—astrin., used in dysen., diar., diabetes. Seeds—cooling, tonic. Leaves—applied as poultice to abscesses. Root fibres—in gonorrhea. (*Hoppe-Seyl. Z.*, 1929, 93). Sub-Himalayan tract and W. Peninsula, planted elsewhere.

F. CARICA Linn. S.—*Anjira*; H. & B.—*Anjir*; Bo.—*Anjra*; Tel.—*Anjuru*; Tam.—*Simaiyatti*; P.—*Fagari*. Fruit—demulc., aper., emol., nutri. Milky juice from the fresh green fruit—acid, used to destroy warts. Protease, amino acid, tyrosin (*Bull. Acad. Roum.*, 1916, 346); enzyme cravin (*Arch. Pharm., Berl.*, 1881, 226); lipase, protease (*C.R. Acad. Sci., Paris*, 1912, 56; *J. Amer. Chem. Soc.*, 1928, 2012); carotin (*J. Biol. Chem.*, 1932, 35); leaves yield 0.06% bitter substance ficusin and bergaptene (*Bull. Chem. Soc., Japan*, 1936, 389; *Chem. Abstr.*, 1936, 7575); latex which resembles ficin and a globulin fraction are very toxic and had a strongly necrotic action on the skin (*Exp. Med. Surg.*, 1945, 11; *Chem. Abstr.*, 1945, 3071). Baluchistan. Cultivated in N.W. India and the Deccan.

F. HISPIDA Linn. f. S.—*Kakadumbura*; H.—*Konea-dumbar*; B.—*Kakdumur*; Bo.—*Rambal*; P.—*Rumbal*; Assam—*Khoskadumar*; Tam. & Mal.—*Peyatti*; Tel.—*Vettiatti*. Fruit, seeds and bark—purg., emetic. Saponin (Dymock, Warden & Hooper, III, 347). More or less throughout India.

F. LACOR Buch.-Ham. S.—*Plaksha*; H. & P.—*Pilkhan*; B.—*Pakar*; Bo.—*Pipili*; Mal.—*Pepar*; Tam.—*Kurugu*; Tel.—*Badijuvvi*. Decoct. of bark—used as a wash for ulcers, as an injection in leucor., as gargle in salivation. Plains and lower hills of India.

F. RACEMOSA Linn. syn. *F. glomerata* Roxb. S.—*Udumbara*; P.—*Kumbal*; H.—*Gular*; B.—*Jagya-dumur*; Bo.—*Umbar*; Tam., Tel. & Mal.—*Atti*. Bark—astrin., given to cattle when suffering from rinder-pest. Root—in dysen. Sap of root—in diabetes. Leaves—powdered and mixed with honey given in bilious affections. Fruit—astrin., stomch., carmin., given in menorrhagia and haemoptysis. Milky-juice—in piles and diar. Throughout India.

F. RETUSA Linn. B. & H.—*Kamrup*; Bo.—*Pilala*; S.—*Kuni*; Tel.—*Yerrajuvvi*; Tam.—*Kallich*. Juice of bark—in liver disease. Powdered leaves and bark—in rheumatic headache. Root-bark and leaves—boiled in oil application for wounds and bruises. Chota Nagpur, Bihar, Madhya Bharat, W. Peninsula, S. India to Ceylon, Sundarbans and Andamans.

FOENICULUM (*Umbelliferae*)

* F. VULGARE Mill.

GARCINIA (*Guttiferae*)

G. INDICA Choisy. H. & Bo.—*Kokam*; Tam.—*Murgal*; Mal.—*Punampuli*. Fruit—antiscor.,

cooling, cholag., emol., demulc. Bark—astrin. Oil—soothing, used in skin diseases (*Pharm. J.*, 65; *J. Soc. Chem. Ind., Lond.*, 1898, 991). Konkan, N. Kanara, W. Ghats of Bombay, S. Kanara, Coorg, Wynaad, often cultivated.

- G. MORELLA Desr. B.—*Tamal*; H.—*Tamel*; Mal.—*Pinnarfuli*; Marathi—*Tamil*; S.—*Tamala*; Tam.—*Irevalsinni*; Tel.—*Pasupuvarne*. Gum resin—purg., anthelm., used in dropsical affections, amenor., obstinate constipation and as vermifuge (*Arch. Pharm., Berl.*, 1891, 426; *Pharm. J.*, 1883, 69). Dry pericarp of seeds yields 10% morellin (*J. Chem. Soc.*, 1937, 853; *Chem. Abstr.*, 1937, 5368). E. Bengal, Khasia Hills, evergreen forests of N. Kanara, W. Ghats from S. Kanara and Mysore to Travancore, up to 3,000 ft.

GENTIANA (*Gentianaceae*)

- G. KURROO Royle. H. & B.—*Karu*; Bo.—*Phashanveda*; P.—*Nilakant*. Root—tonic, stomch., febrg., for urinary affections and as a *masala* for fattening horses. Kashmir and N.W. Himalayas, 5,000–11,000 ft.

GLORIOSA (*Liliaceae*)

- G. SUPERRA Linn. S.—*Shakrapushpi*; H.—*Kalihari*; B.—*Bishalanguli*; Bo.—*Karianag*; P.—*Kariari*; Tam.—*Akkinichilam*; Tel.—*Agnisikhha*. Root—purg., cholag., anthelm., used in leprosy, parasitical affections of skin, piles, colic, in snake-bites and scorpion-stings. Starch from root—given internally in gonorr. Alks. superline, gloriosine (*Indian Med. Gaz.*, 1880, 253; *Meded. P.Tuin. Batavia*, 1899, 71; *J. Chem. Soc.*, 1915, 835; *Ber. Dtsch. Chem. Ges.*, 1920, 2069); colchicine (*Curr. Sci.*, 1941, 446). Throughout tropical India ascending to 7,000 ft. on the hills. Common in Mysore State.

GLYCYRRHIZA (*Leguminosae*)

- * G. GLABRA Linn.

GMELINA (*Verbenaceae*)

- G. ARBOREA Linn. S.—*Gumbhari*; H.—*Gamari*, *Khambhari*; B.—*Gamari*; Bo.—*Shewun*; P.—*Gumhar*; Tam.—*Kallanam*; Tel.—*Gummadi*. Juice of leaves—demulc., used in gonorr., cough, and to remove foetid discharges and worms from ulcers. Plant—used in snake-bite and scorpion-sting. Throughout India.

GOSSYPIUM (*Malvaceae*)

- G. ARBOREUM Linn. H.—*Nurma*; P.—*Kapas*; Bo.—*Deokapas*; Mal.—*Chemparutti*; S.—*Karpasamu*; Tam.—*Sembarutti*; Tel.—*Patti*. Root—used in fever. Seeds—in gonorr., gleet, chr. cystitis, catarrh, consumption. (*J. Soc. Chem. Ind., Lond.*, 1899, 161; 1909, 2131; 1916, 145, 1191; *J. Amer. Chem. Soc.*, 1923, 1944; 1924, 405; 1925, 1731). Grown in gardens and about temples.

GREWIA (*Tiliaceae*)

- G. ASIATICA Linn. S.—*Parusha*; H., P. & B.—*Phalsa*; Tam.—*Palisa*; Tel.—*Pedda-jana*. Fruit—astrin., cooling, stomch. Infusion of bark—demulc. Root-bark—in rheumatism. Leaves—used as application to pustular eruptions. Extensively cultivated throughout India; in the wild state unknown.
- G. TILIAEFOLIA Vahl. S.—*Dharmana*; H., P. & B.—*Dhamani*; Bo.—*Damana*; Tam.—*Tarra*; Tel.—*Charachi, Jana*; Mal.—*Satachi*. Bark—used in dysen., employed externally to remove the irritation from cow-itch. Wood—in powder form emetic, antid. to opium poisoning. Sub-Himalayan region from the Jumna to Nepal up to 4,000 ft., Madhya Bharat, all districts of Madras State, Bihar and Orissa.

GYNANDROPSIS (*Capparidaceae*)

- G. GYNANDRA (Linn.) Briquet syn. *G. pentaphylla* DC.; *Cleome pentaphylla* Linn. S.—*Surjavarta*; H.—*Karalia*; B.—*Hurhuria*; Bo.—*Tilavana*; Mal.—*Taivcla*; Tam.—*Kadugu*; Tel.—*Vaminta*. Decoct. of root—used in fever. Leaves—rubft., vesic., in rheumatism. Juice of leaves—remedy for otalgia. Seeds—anthelm., rubft. Plant—in scorpion-sting and snake-bite. Essen. oil (Dragendorff, *Heilpflanzen*, 260); seeds contain cleomin (*Proc. Nat. Inst. Sci. India*, 1937, 45; *Chem. Abstr.*, 1938, 2137). A common weed abundant throughout the warmer parts of India.

HARDWICKIA (*Leguminosae*)

- H. PINNATA** Roxb. Mal.—*Kodapalla*; Kan.—*Enne*; Marathi—*Anjana*; Tam.—*Kodapalai*. Balsam—used for gonorrhea. Yields balsam similar to Copaiba balsam and used as such; essen. oil (*Ber. Schimmel u. Co., Lpz.*, 1905, April, 86; 1907, April, 116; *Arch. Pharm., Berl.*, 1908, 71); the oil as reported by the Imperial Institute, London, cannot be a substitute for copaiba oil (Kirtikar & Basu, II, 882); olcoresin (*J. Indian Inst. Sci.*, 1918-20, II, 29). Evergreen forests of the W. Ghats from S. Kanara to Travancore.

HEDYCHIAM (*Zingiberaceae*)

- H. SPICATUM** Ham. ex Smith. S.—*Karchura*, *Karpur*; H.—*Sitruti*; Marathi—*Kapurakachari*; B.—*Gandha-shati*; Bo.—*Sutti*; Tam.—*Simaikkichilik-kilhangu*. Rootstock—stomach, carmin., tonic, stim., emmen., expect., good in liver complaints, vomiting, diarr., inflam. and pains; used in snake-bite. Essen. oil, methyl paracumarin acetate, cinnamic ethyl acetate (*Dtsch. Apoth. Ztg.* 1884, 560; Wehmer, I, 179); rhizomes yield 4% essen. oil containing ethyl-p-methoxy cinnamate 67.8, ethyl cinnamate 10.2, *d*-sabinene 4.0, 1:4-cincole 6.0, sesquiterpenes (probably cadinene) 5.5, sesquiterpene alcohol 4.7% (*Indian Soap J.*, 1940, 248; *Chem. Abstr.*, 1940, 6015). Subtropical Himalayas, Nepal, Kumaon, 5,000-7,000 ft.

HELIANTHUS (*Compositae*)

- H. ANNUUS** Linn. S.—*Surya-mukhi*; H.—*Surjamukhi*; B.—*Suraja-mukhi*; Bo.—*Surajmaki*; Tel.—*Adityabhaktichettu*; M.—*Suriyakandi*. Seeds—diur., expect., used in bronchial, laryngeal, pulmonary affections, coughs and colds, in scorpion-sting. (*J. Amer. Chem. Soc.*, 1897, 487; 1922, 2952; *Biochem. Z.*, 1919, 1; *J. Soc. Chem. Ind., Lond.*, 1927, 433T.); chlorogenic acid (*Chem. Zbl.*, 1933, II, 1617); leaves—carotin., lutein (*Ber. Dtsch. Chem. Ges.*, 1934, 170; *Zhem. Zbl.*, 1934, I, 2436). Cultivated in India. A native of America.

HELICTERES (*Sterculiaceae*)

- H. ISORA** Linn. S.—*Mriga-shinga*; H.—*Marorphali*; B.—*Atmora*; Bo.—*Kevana*; Tam.—*Valumberi*; Tel.—*Valambiri*; P.—*Marorphali*. Fruit—demulc., astrin., useful in the griping of bowels and flatulence of children. Bark—in dysent., and diarr. Juice of root—in diabetes empyema, stomach affections and snake-bite. Root and bark—expect., demulc., astrin. to the bowels, antilactagogue; lessen griping; a cure for scabies when applied topically. Dry forests throughout central and western India, from Bihar as far west as Jammu and Western Peninsula.

HELIOTROPIUM (*Boraginaceae*)

- H. INDICUM** Linn. S.—*Hastisunda*; H. & B.—*Hatisura*; Bo.—*Burundi*; Tam.—*Telkodukki*. Leaves—applied to boils, ulcers, wounds and in stings of insects and reptiles. Plant—diur. Alk. (Dymock, Warden & Hooper, II, 526; *Arch. Pharm., Berl.*, 1900, 505). Throughout India.

HEMIDESMUS (*Asclepiadaceae*)

- * **H. INDICUS** R. Br.

HERPESTIS (*Scrophulariaceae*)

- * **H. MONNIERA** (Linn.) H. B. & K.; see *BACOPA MONNIERI* (Linn.) Pennell.

HIBISCUS (*Malvaceae*)

- H. CANNABINUS** Linn. S.—*Nali*; H.—*Patsan*; B.—*Mestapat*; Bo.—*Ambari*; Tam.—*Pulichai*; Tel.—*Gongura*. Juice of flowers—with sugar and black pepper in biliousness with acidity. Seeds—aphrodis., fattening, as external application to pains and bruises. Leaves—purg. Seeds—fatty oil like arachis oil (*Pharm. Weekbl.*, 1922, 1926) radium, thorium, rubidium (*Biochem. Z.*, 1931, 58; *Chem. Zbl.*, 1931, I, 3575); petals contain glucd. cannabiscitrin and flavonol cannabiscetin (*Curr. Sci.*, 1938, 504; *Chem. Abstr.*, 1938, 5846). Generally cultivated. Apparently a native of Africa.

- H. ROSA-SINENSIS** Linn. S. & B.—*Joba*; H.—*Jasum*; Bo.—*Jasavanda*; Tam.—*Sapattuppu*; Tel.—*Dasanam*. Root—in cough, subst. for Althaea. Leaves—emol., aper. Flowers—

emol. Infusion of petals—given as demulc. and refrig. drink in fevers. Cultivated in gardens throughout India.

HOLARRHENA (*Apocynaceae*)

* *H. ANTIDYSENTERICA* Wall.

HOLOPTELEA (*Ulmaceae*)

H. INTEGRIFOLIA Planch. H. & P.—*Papri*; Marathi—*Vavala*; S.—*Chirabilva*; Tam.—*Aya*; Tel.—*Nemali*. Juice of boiled bark—applied to rheum. swellings. Sub-Himalayas, Ajmere, Bundelkhand, Bihar, Assam and W. Peninsula.

HORDEUM (*Gramineae*)

H. VULGARE Linn. syn. *H. sativum* Pers. H., P. & Bo.—*Jau*; Bo.—*Jav*; S.—*Divya*; Tam.—*Barliyarisi*; Tel.—*Barilibiyann*. Grains—demulc., easy of digestion, used in the dietary of sick, parched and powdered much employed in the form of a gruel in cases of painful and atonic dyspep. As—55 mg. in 100 g. dry and 50 mg. in 100 g. fresh plant (*C.R. Acad. Sci., Paris*, 1914, 268; *Chem. Zbl.*, 1914, 11, 885; *J. Amer. Chem. Soc.*, 1931, 3046). Cultivated chiefly in N. India and up to 13,000 ft. in the Himalayas.

HYDNOCARPUS (*Flacourtiaceae*)

* *H. KURZII* (King) Warb. syn. *Taraktogenos kurzii* King.

HYDROCOTYLE (*Umbelliferae*)

* *H. ASIATICA* Linn.; See *CENTELLA ASIATICA* (Linn.) Urban.

HYGROPHILA (*Acanthaceae*)

* *H. SPINOSA* T. And.; see *ASTERACANTHA LONGIFOLIA* Nees.

HYOSCYAMUS (*Solanaceae*)

* *H. NIGER* Linn.

ICHNOCARPUS (*Apocynaceae*)

I. FRUTESCENS R. Br. S.—*Suriva*; H.—*Kalidudhi*, *Siamalata*; B.—*Dudhi*, *Shyamalata*; Tel.—*Illukkatti*; Tam.—*Udargodi*; Mal.—*Pakvalli*. Root—properties similar to *Hemidesmus indicus*, alter., tonic, subst. for Sarsaparilla. Decoct. of leaves and stalks—in fever. More or less throughout India.

INDIGOFERA (*Leguminosae*)

I. TRIFOLIATA Linn. Bo.—*Vekaria*; H.—*Ganglimethi*; Marathi—*Lalmeti*; Tel.—*Baragadamu*. Seeds—restor., alter., astrin., aphrodis., tonic, used in rheumatism and leucor. Throughout India.

IPOMOEA (*Convolvulaceae*)

I. HEDERACEA (Linn.) Jacq. H., B. & Bo.—*Kaladana*; S.—*Krishnabija*; Tam.—*Kakkattan*; Tel.—*Jirki*. Seeds—purg., subst. for jalap. Glucd. (*Arch. Pharm., Berl.*, 1896, 459; *Pharm. J.*, 1924, 155; *J. Pharm. Soc. Japan*, 1922, 419; *J. Coll. Agric. Tokyo*, 1931, 241; *Proc. imp. Acad., Japan*, 1926, 274; 1934, 389; *Chem. Zbl.*, 1934, I, 3605); resin 14.2-15.3% (*Indian J. Pharm.*, 1948, 70; *Chem. Abstr.*, 1949, 3565). Throughout India, both cultivated and apparently wild, up to 6,000 ft. in the Himalayas.

I. PANICULATA R. Br. S.—*Bhumikushmanda*; H.—*Bilaikand*; B.—*Bhumikumra*; Bo.—*Bhuikohala*; Mal.—*Palmutakku*; Tam.—*Nilappuchani*; Tel.—*Palamodikku*. Roots—tonic, alter., aphrodis., demulc., lactag., purg., cholag., in scorpion-sting. Resin similar to jalap resin. Throughout tropical India in moist regions.

I. RENIFORMIS Choisy. S.—*Mushakarni*; H.—*Musakani*; B.—*Undirakanipana*; Bo.—*Undirkani*; Tam.—*Perettaikkiray*; Tel.—*Toinnualali*. Plant—deobstruent, diur., alter., used in rheumatism and neuralgia. Bengal, Konkan, Deccan and Carnatic.

JASMINUM (*Oleaceae*)

J. AURICULATUM Vahl. S., Kan. & Tel.—*Magadhi*; Tam.—*Udigai*; Mal.—*Bolidda*. Flowers—given in consumption. Deccan, Carnatic, W. Peninsula.

J. OFFICINALE Linn. (S.—*Ganika*; H. & Kash.—*Chamba*; P.—*Dummi*, *Suni*; Kan.—*Sannajajimallige*. Root—used in ringworm. Alk. jasmin; essen. oil (*Repert. Pharm.* 1834, 101; *Ber. Schimmel u. Co., Lpz.*, 1929, 51). Himalayas 3,000-9,000 ft. from the

Indus eastwards, extending into the inner valleys, Trans-Indus. Often cultivated in India.

J. OFFICINALE Linn. var. GRANDIFLORUM Bailey syn. *J. grandiflorum* Linn. S. & H.—*Chambeli, Jati*; B.—*Chameli, Jati*; Tam.—*Pichi*; Mal.—*Pichakam*; Bo.—*Chambeli*; Tel.—*Jaji*. Leaves—chewed as a treatment for ulcerations or eruptions in the mouth; the fresh juice applied to corns; an oil prepared with the juice of leaves poured into the ear in otorrhoea. Flowers—used as an application in skin diseases, headache and weak eyes, in scorpion-sting. Plant—anthelm., diur., emmen. Alk., salicylic acid (Dymock, Warden & Hooper, II, 378); essen. oil (*Chem. & Drugg.*, 1929, 778; *Chemikerztg.*, 1910, 912; *J. Soc. Chem. Ind., Lond.*, 1909, 227; *Ber. dtsh. Chem. Ges.*, 1933, 1521; *Chem. Zbl.*, 1933, 3571; *Chem. Abstr.*, 1940, 7534; *Indian Soap J.*, 1951, 235, 259; *Chem. Abstr.*, 1951, 10507).^{*} Sub-tropical N. W. Himalayas 2,000-5,000 ft., Salt Range, Trans-Indus, eastwards to Kumaon, hills of Rajasthan and Madhya Bharat. Often cultivated in Indian gardens.

J. SAMBAC Ait. S.—*Mallika*; H.—*Motia, Murga*; B.—*Bcl, Mogra*; B.—*Mogri*; Tam.—*Malligai*; Tel.—*Bondumalle*; Mal.—*Mulla*. Plant—cooling, used in cases of insanity, weakness of sight, and affections of the mouth. Root—emmen. Flowers—lactifuge, applied unmoistened to breasts to arrest secretion of milk in puerperal state in cases of threatened abscess. Dried leaves—soaked in water and made into a poultice used in indolent ulcers.

JATROPHA (*Euphorbiaceae*)

J. GLANDULIFERA Roxb. S.—*Nikumba*; B.—*Lalbherenda*; II. & Bo.—*Janglierandi, Undarbibi*; Mal.—*Nakadanti*; Tam.—*Adalai*; Tel.—*Dundigamu*. Fixed oil from seeds—purg., used in chr. ulcerations, foul wounds, ringworm, in rheumatism and paralysis. Juice of the plant—used to remove film from the eyes. Root—brayed with water given to children suffering from abdominal enlargements; purg., said to reduce glandular swellings. Bengal, Northern Circars, Deccan and Carnatic, from the Krishna river southwards, rare in Oudh and Punjab.

JUGLANS (*Juglandaceae*)

J. REGIA Linn. S.—*Akschota*; H. & B.—*Akhrot*; Bo. & Marathi—*Akroda*; Tam. & Tel.—*Akrottu*. Bark—anthelm., detergent. Leaves—astrin., tonic, in decoct. considered to be specific in strumous sores, anthelm. Fruit—alter. in rheumatism. Alk., barium (*Amer. J. Pharm.*, 1886, 468; *Ber. dtsh. Chem. Ges.*, 1884, 1045; *J. Amer. Chem. Soc.*, 1896, 609; 1903, 845); As—0.013 mg. in 100 g. seeds (*C.R. Acad. Sci., Paris*, 1912, 893); oxalic acid in fruits (*Chem. News*, 1916, 62); juglon (*Pharm. Zentralh.*, 1931, 97; *Chem. Zbl.*, 1931, I, 3379).^{*} Temperate Himalayas 3,000-10,000 ft., wild and cultivated, Khasia Hills, cultivated, and Baluchistan.

LAUNAEA (*Compositae*)

L. PINNATIFIDA Cass. Bo.—*Pathri*; Marathi & Gujarati—*Bhonpatri*; H.—*Bankau*. Plant—given as lactag., used as subst. for Taraxacum. Juice—used as soporific for children and applied in rheum. affections. Sandy coasts of India.

LEPTADENIA (*Asclepiadaceae*)

L. RETICULATA W. & A. Bo.—*Dodhi*; H.—*Dori*; S.—*Jivanti*; Tam.—*Palakudai*; Tel.—*Palatige*. Plant—stim., tonic. Punjab and W. Peninsula.

LEUCAS (*Labiatae*).

L. CEPHALOTES Spreng. S.—*Dronapushpi*; H.—*Goma, Motapati*; B.—*Barahalkasa*; Marathi—*Tumba*; Tel.—*Tummi*; P.—*Maldoda*. Plant—stim., diaphor., insecticide. Fresh juice—external application in scabies. Flowers—in form of a syrup used as remedy for cough and colds. Essen. oil; alk. (Dymock, Warden & Hooper, III, 125). Kashmir, Punjab, Bengal, Assam, Himalayas, Rajasthan Desert, Kathiawar, Gujarat and all plains of Madras State.

LINUM (*Linaceae*)

L. USITATISSIMUM Linn. S. & Tel.—*Atasi*; H.—*Alsi*; B.—*Masina, Tisi*; Bo.—*Alasi*;

Tam.—*Alshi*; Mal.—*Cheruchanavittintevilla*. Dried ripe seeds—used as demulc. and in form of poultices; as poultice useful for gouty and rheum. swellings; used internally for gonorr. and irritation of the genito-urinary system. Bark and leaves—used in gonorr. Flowers—nervine and cardiac tonic. Oil—mixed with linewater used as application to burns. Seeds contain HCN-glucd. linamarin (*Chem. Zbl.*, 1907, I, 1440); 0.0812 mg. arsenic oxide in 1 kg. seeds (*Pharm. Weekbl.*, 1921, 1482; *Chem. Zbl.*, 1922, II, 113); flowers with immature seeds contain 0.69% HCN; one-half lb. of flowers will cause death of bullocks (*Indian J. vet. Sci.*, 1930, 61; *Chem. Abstr.*, 1940, 2071) seeds contain about 30 to 40% of fixed oil, 6% mucilage, 25% proteins, together with wax, resin, sugar, phosphates and a small quantity of the glycoside, linamarin (B.P.C., 474). Cultivated throughout India up to 6,000 ft.

LIPPIA (*Verbenaceae*)

* L. NODIFLORA Mich.

LUFFA (*Cucurbitaceae*)

L. ACUTANGULA Roxb. S.—*Koshataki*; H.—*Jinga, Torai*; Bo.—*Turai*; B.—*Jhinga*; Tam.—*Pikunkai*; Tel.—*Burkai*; Mal.—*Puichenggah*. Seeds—emetic, purg. Juice of fresh leaves—dropped into the eyes in granular conjunctivitis. Pounded leaves—applied locally to splenitis, haemorrhoids and leprosy. Bitter substance luffin (*Pharm. J.*, 1890, 997; *J. Soc. Chem. Ind., Lond.*, 1898, 991; 1910, 1428); seeds contain 20% of a saponin glycoside, enzyme and a fixed oil; oil causes salivation, vomiting and purging in dogs (*Indian J. Med. Res.*, 1943, 63; *Chem. Abstr.*, 1944, 5003). Cultivated throughout the greater part of India.

LUVUNGA (*Rutaceae*)

L. SCANDENS Buch.-Ham. S.—*Lavangalata*; B.—*Labangaphal*. Berries—used in preparing a perfumed medicinal oil. Root and fruit—used in scorpion-sting. Four crystalline neutral compounds isolated from mature fruits (*J. Indian Chem. Soc.*, 1944, 181). Eastern Bengal, Assam, Khasia Hills and Chittagong.

MADHUCA (*Sapotaceae*)

* M. INDICA J. F. Gmel. syn. *M. latifolia* (Roxb.) Macbride; *Bassia latifolia* Roxb.

MAJORANA (*Labiatae*)

M. HORTENSIS Moench syn. *Origanum majorana* Linn. S.—*Maru*; B.—*Murru*; Bo.—*Murwo*; Tam.—*Marru*; Dec. & H.—*Murwa*; Kumaon—*Bantulsi*. Plant—carmin., expect., tonic to the liver. Leaves and seeds—astrin., remedy for colic. Essen. oil from leaves—used for hot fomentations in acute diar. Essen. oil, bitter substance (*Ber. Schimmel u. Co., Lpz.*, 1926, 70; 1918, 34; *Ber. dtsh. chem. Ges.*, 1907, 596); intravenous injection of 1 c.c. per kg. body weight of dogs of a saturated solution of essen. oil in 33% ethyl alcohol increased peristaltic movements of intestine (*C.R. Soc. Biol., Paris*, 1945, 210; *Chem. Abstr.*, 1946, 3527). Extensively cultivated in India.

MALLOTUS (*Euphorbiaceae*)

* M. PHILIPPINENSIS Muell.-Arg.

MANGIFERA (*Anacardiaceae*)

M. INDICA Linn. S.—*Amra*; B.—*Am*; H. & Bo.—*Am, Amb*; Tam.—*Mamaram*; Tel.—*Amramu*; Mal.—*Amram*. Leaves—in scorpion-sting. Ripe fruit—laxt., diur., astrin., useful in haemor. from uterus, lungs or intestines. Unripe fruit—useful in ophthalmia and eruptions. Rind of fruit—astrin., stim. tonic in debility of stomach. Seeds—used in asthma. Kernel—astrin., used in haemor., in diar., anthelm., its juice if snuffed can stop nasal bleeding. Bark—astrin., used in uterine haemor., haemoptysis and melaena, diar. and other discharges. (*Chemikerztg.*, 1897, 719; *Pharm. J.*, 1907, 718); Fruit—vitamins A, C and D (*Biochem. J.*, 1933, 1290; *Chem. Zbl.*, 1934, I, 563; *Philip. J. Sci.*, 1934, 379; *Chem. Zbl.*, 1934, II, 270); vitamin B (*Indian J. Med. Res.*, 1933, 1045). Probably indigenous in Sikkim, the Nambiar forests in Assam, the Khasia Hills, in ravines on the higher hills of the Satpura range, in Khandesh and along the W. Ghats. Cultivated in the tropics generally.

MARSDENIA (*Asclepiadaceae*).

M. ROYLEI Wright. H.—*Murkula*, P. & Simla—*Kurang*; Kumaon—*Murkila*; Almora—*Murkhila*; Dehra Dun—*Maruabel*. Unripe fruit—cooling and alter. Decoct.—used as remedy in gonorr. Western and Eastern Himalayas, from Simla to Kumaon, ascending to 5,000 ft., Sikkim, 4,000 ft.

MENTHA (*Labiatae*)

M. PIPERITA Linn. English—*Peppermint*. Essen. oil from plant—antisept., stim., carmin. Herb—stim., stomachic, carmin., used for allaying nausea, sickness, vomiting and as infants cordial. Yields essen. oil 0.5-1.5% containing 56% free menthol and 4% esters (*Sci. Pharm.*, 1937, 33; *Chem. Abstr.*, 1937, 4054); menthol content varies between 36.2-56% and ester 4.4-9.9% (*Rep. Hung. agric. Exp. Sta.*, 1939, 93; *Chem. Abstr.*, 1939, 7485; *Mitt. naturf. Ges. Bern.*, (1937) (1938), 21; *Chem. Abstr.*, 1939, 5129); yield of menthol decreases by 30% if harvested 10-15 days earlier or later (*Proc. Amer. Soc. hort. Sci.*, 1944, 451; *Chem. Abstr.*, 1945, 4192). Cultivated in Indian gardens.

MICHELIA (*Magnoliaceae*)

M. CHAMPACA Linn. H. & B.—*Champa*, *Champak*; Bo.—*Champa*; S.—*Champak*; Marathi—*Kudchampa*; Mal.—*Champakam*; Tam.—*Shampangi*; Tel.—*Champakmu*. Bark—febrif., stim., expect., astrin. Dried root and root bark—purg., in form of infusion useful in emmen.; mixed with curdled milk useful application to abscesses. Flowers and fruits—considered stim., antisp., tonic, stomachic, carmin., bitter and cooling, used in dyspep., nausea and fever; useful as diur. in renal diseases and in gonorr.; mixed with sesamum oil form an external application in vertigo. Oil from flowers—useful application in cephalalgia, ophthalmia and gout. Juice of leaves—given with honey in colic. Seeds and fruit—used for healing cracks in feet. Essen. oil (*Philipp. J. Sci.*, 1909, 131A; 1910, 262; 1911, 333; *J. Amer. Chem. Soc.*, 1911, 1763; *Parfum. Mod.*, 1927, 98); essen. oil 0.11% (*Bull. imp. Inst., Lond.*, 1934, 253; *Chem. Zbl.*, 1934, II, 2613). Wild in the E. sub-Himalayan tract and lower hills up to 3,000 ft., Assam, W. Ghats, S. India. Much cultivated in various parts of India.

MIMOSA (*Leguminosae*)

M. RUBICULIS Lam. H. & B.—*Shiah-kanta*; Bo.—*Huziru*; Garhwal—*Khinkari*; Mal.—*Kattusinikka*; P.—*Arlu*; Tam.—*Ingai*; Tel.—*Undra*. Leaves—in form of infusion prescribed in piles; bruised and applied to burns. Root—in powder form given when from weakness the patient vomits his food. Throughout India.

M. SUMA Roxb.; see ACACIA SUMA Buch.-Ham.

MIMUSOPS (*Sapotaceae*)

M. ELENGI Linn. S.—*Bakula*; H. & B.—*Bakul*; Bo.—*Borsali*; Mal.—*Bakulam*; P.—*Maulsari*; Tam.—*Magilam*; Tel.—*Vakulam*. Bark—astrin., tonic, useful in fevers. Leaves—in snake-bite. Pulp of ripe fruit—astrin., used in curing chr. dysen. Seeds—bruised and locally applied within the anus of children in cases of constipation. Saponin (*J. Soc. Chem. Ind., Lond.*, 1910, 1430; *Chem. Zbl.*, 1930, 2895); kernel yields an oil. W. Peninsula, southwards from Khandala Ghat on the west and the N. Circars on the east side and Andamans.

MORINDA (*Rubiaceae*)

M. CITRIFOLIA Linn. H. & B.—*Ach*; S.—*Ashyuka*; Bo.—*Aal*; M.P. & Dec.—*Al*; Mal.—*Mannanatti*; Tam.—*Vellainuna*; Tel.—*Mulugu*. Root—cath. Leaves—administered internally as tonic and febrif.; used as a healing application to wounds and ulcers. Baked fruit—in Indo-China used as emmen., and given in asthma and dysen. Unripe berries—charred and mixed with salt applied successfully to spongy gums. Juice of leaves—applied to gout externally. Glucd. morindin (*Arch. Pharm., Berl.*, 1907, 534, 281; *J. Chem. Soc.*, 1887, 87; 1920, 561; 1918, 766); yields anthraquinone derivatives (U.S.D., 1524). Indigenous to the Darjeeling Terai and outer hills and on the Andamans and along the Konkan coast; cultivated largely in India.

MORINGA (*Moringaceae*)

* M. OLEIFERA Lam. syn. *M. Pterygosperma* Gaertn.

MORUS (*Moraceae*)

M. ACEDOSA Griff. syn. *M. indica* Linn. S.—*Shalmali*; H., P., B. & Bo.—*Tut*; Mal.—*Yusham*; Tam.—*Kambali*; Tel.—*Putika*. Fruit—arom., cooling, laxt., allays thirst, grateful in fevers. Bark—anthelm., purg. Leaves—in decoct. used as gargle in inflam. of vocal cords. Root—anthelm., astrin. Wild in the sub-Himalayan tract from the Sutlej eastwards, up to 5,000 ft. Cultivated elsewhere.

MUCUNA (*Leguminosae*)

M. PRURIENS Bak. (Fl. Br. Ind., II, 187, non DC.); see M. PRURITA Hook.

M. PRURITA Hook. syn. *M. pruriens* Bak. (Fl. Br. Ind., II, 187, non DC.). S.—*Atmagupta*; H. & P.—*Kawanch*; B.—*Alkusa*; Bo.—*Kuhili*; Mal.—*Shoriyanam*; Tel.—*Dulagondi*; Tam.—*Punaikkali*. Seeds—aphrodis., nervine tonic, in scorpion-sting. Pods—anthelm. Root—purg., prescribed as remedy for delirium in fever; powdered and made into a paste applied to the body in dropsy; strong infusion mixed with honey given in cholera. (*Chm. Zbl.*, 1923, I, 1372; 1921, I, 456); seeds give 4% reddish viscous oil and alks. mucunine and mucunadine (*Indian J. Pharm.*, 1944, 92; *Chem. Abstr.*, 1946, 3227). Punjab plains, from the base of the Himalayas to Ceylon and Burma.

MUSA (*Musaceae*).

M. PARADISIACA Linn. S.—*Kadali*; H. & Bo.—*Kela*; B.—*Kala*. Root—anthelm. Flowers—astrin. Juice of stem—in otalgia and haemoptysis. Analysis of fruit. (*J. Amer. Chem. Soc.*, 1912, 1706; *Chem. Zbl.*, 1921, IV, 137; *C.R. Acad. Sci., Paris*, 1912, 893; *Apothekerztg. Berl.*, 1910, 440). Commonly cultivated.

MYRICA (*Myricaceae*).

M. NAGI Thunb. S.—*Katphala*; H., P., B. & Bo.—*Kaiphali*; Tam.—*Marudam*; Tel.—*Kaidaryamu*; Mal.—*Marula*. Bark—astrin., carmin., antisept., useful in fever, asthma, cough; powdered and used as snuff in catarrh with headache; mixed with ginger used as a rubft. application in cholera; fish poison. (*J. Chem. Soc.*, 1896, 1287; *Proc. Chem. Soc., Lond.*, 1902, 11); contains the glycoside myricitrin (*J. Chem. Soc.*, 1925, 183). Subtropical Himalayas from the Ravi eastwards at 3,000-6,000 ft., Khasia Hills, and Sylhet.

MYRISTICA (*Myristicaceae*)

* M. FRAGRANS Houtt.

NARDOSTACHYS (*Valerianaceae*)

N. JATAMANSI DC. S., H. & B.—*Jatamansi*; Bo.—*Balacharea*; Tam.—*Jatamashi*; Garhwali—*Masi*; Tel.—*Jatamamshi*; Mal.—*Jetamanshi*; Kash.—*Bhutijalt*. Root—arom., bitter, tonic, stim., antisp., employed for treatment of epilepsy, hysteria and convulsive affections; used in palpitation of heart; subst. for Valerian; useful in intestinal colic. Essen. oil (Dymock, Warden & Hooper, II, 237; *Ber. Schimmel u. Co., Lpz.*, 1907, Oct., 65; 1926, 75); a crystalline acid jatamansic acid has been isolated (*J. Sci. Industr. Res.*, 1951, 48B)*. Alpine Himalayas, 11,000-15,000 ft., extending eastwards from Kumaon to Sikkim, 17,000 ft. and Bhutan.

NELUMBium (*Nymphaeaceae*)

* N. SPECIOSUM Willd.

NERIUM (*Apocynaceae*).

N. INDICUM Mill. syn. *N. odorum* Soland. S.—*Karavira*; H. & P.—*Kaner*; B.—*Karabi*; Bo.—*Kanhera*; Tam., Tel. & Mal.—*Karaviram*. Plant—poisonous. Root—powerful resolv. and attenuant, used externally; beaten into a paste with water applied to chancres and ulcers on the penis. Decoct. of leaves—used to reduce swellings. Oil prepared from root-bark—used in skin diseases of a scaly nature, and in leprosy. Glucd. (*Chem. Zbl.*, 1881, 218; *Proc. Chem. Soc., Lond.*, 1901, 92); root, bark and seeds contain the toxic principles neriodorin, nerioderin and karabin (*Pharm. J.*, 1880, 873; *Proc. nat. Acad. Sci. India*, 1934, 209; *Indian med. Gaz.*, 1901, 287, 408); like neriodorin, karabin is a powerful cardiac poison and acts on the heart in a somewhat similar manner as

digitalin (*Indian Med. Gaz.*, 1901, 287, 408); glucd. odorin causes paralysis of mice and rabbits, depresses respiration; lethal dose for frogs 300-350, mice 400-450 and rabbits 150-200 mg./kg. (*J. Okayama med. Soc.*, 1938, 2426; *Japan J. Med. Sci.*, IV, No. 1. *Abstr.* 37, 1939; *Chem. Abstr.*, 1940, 7434); leaves contain a compound giving reactions described for rutin (*J. Pharm. Soc. Japan*, 1949, 321; *Chem. Abstr.*, 1950, 1977); leaves, flowers, bark and woody parts show cardiotonic potency and lethal dose comparable to digitalis (*Sci. Technol. China*, 1948, 35; *Chem. Abstr.*, 1950, 6573).^{*} Upper Gangetic Plain, Himalayas from Nepal westwards to Kashmir up to 6,500 ft., Salt Range, Waziristan, Baluchistan, Central and S. India. Extensively cultivated throughout the greater part of India.

NIGELLA (*Ranunculaceae*)

N. SATIVA Linn. S.—*Krishnajiraka*; B.—*Kalijira*; H.—*Kalonji*, *Kalajira*; Bo.—*Kalenjire*; Tam.—*Karunjiragam*; Tel.—*Nullajilakara*; Mal.—*Karunshiragam*. Seeds—stim., carmin., diur., emmen., galact.; useful in mild cases of puerperal fever; reduced to powder and mixed with sesamum oil much used as an external application in eruptions of the skin; for scorpion-sting. Seeds contain essen. oil, tox. glucd. melanthin, bitter substances (*J. Chem. Soc.*, 1880, 718; *Pharm. J.*, 1882, 681; 1884, 863; *Arch. exp. Path. Pharmac.*, 1883, 440; *Ber. Schimmel u. Co., Lpz.*, 1895, April, 74; 1913, Oct. 97); 1.5% essen. oil, and 35% fixed oil and amorphous glycosidal saponin melanthin (U.S.D., 1532); the amount of saponin is variable (*Jb. wiss. Bot.*, 1937, 710; *Chem. Abstr.*, 1938, 9177); also 1% melanthigenin (*J. Chem. Soc.*, 1943, 70; *Chem. Abstr.*, 1943, 3441); an amorphous compound giving reactions of saponin isolated (*Univ. Allahabad Studies*, 1946, *Chem. Sec. I*; *Chem. Abstr.*, 1947, 6672).^{*} Punjab, Bihar and other parts of India, cultivated and an occasional weed of cultivation.

NYCTANTHES (*Oleaceae*).

N. ARBORTRISTIS Linn. S.—*Sephalika*; P., H. & B.—*Harsinghar*; Bo.—*Harsingara*; Tam.—*Pavala-malligai*; Tel.—*Sepali*; Mal.—*Mannapu*. Leaves—useful in fever and rheumatism; fresh juice given with honey in chr. fever. Decoct. of leaves—prepared over a gentle fire, recommended as a specific for obstinate sciatica. Expressed juice of leaves—cholag., laxt., mild bitter tonic, given with little sugar to children as remedy for intestinal worms. Flowers yield crystalline nyctanthin, leaves alk., resins, peppermint-like oil, amorphous glucd. (Dymock, Warden & Hooper, II, 378; *J. Chem. Soc.*, 1907, 1); leaves yield glucd., 1% essen. oil (*Proc. nat. Acad. Sci. India*, 1933, 83). Outer Himalayan ranges from the Chenab to Nepal, Assam, Bengal, Madhya Bharat southwards to the Godavari. Cultivated in many parts of India.

NYMPHAEA (*Nymphaeaceae*).

N. STELLATA Willd. S.—*Nilotpala*; Marathi—*Krishna kamal*; H.—*Nilkamal*; B.—*Nil-sapla*; Bo.—*Upliakamal*; Tel.—*Nitikulava*; Mal.—*Sitambel*. Powdered rootstock—given in dyspep., diar. and piles. Decoct. of flowers—prescribed in palpitation of heart. Warmer parts of India.

OCIMUM (*Labiatae*).

O. AMERICANUM Linn. syn. *O. canum* Sims. H. & B.—*Kala tulshi*; S.—*Ajaka*; Kan.—*Ramatulasi*; M.—*Nayttulsi*; Mal.—*Katturamatulasi*; Tam.—*Ganjamkorai*; Tel.—*Kukkutulasi*. Leaves—made into paste used in parasitical skin diseases and applied to the finger and toe-nails during fever when the extremities are cold. (*Ber. Schimmel u. Co., Lpz.*, 1903, April, 33; 1925, 54; 1929, 70; 1934, 51); plant yields 0.6% essen. oil containing 16-25% true camphor (*E. Afr. agric. J.*, 1936, 302, 308; *Chem. Abstr.*, 1936, 6510); entire plant yields 0.5-0.8% essen. oil containing 65% camphor (*Drug Cosmet. Ind.*, 1938, 546; *Chem. Abstr.*, 1939, 311; *Farm. Zh.*, 11, No. 1, 1938, 27; *Chem. Abstr.*, 1939, 316); mature plant (leaves, soft twigs and flowering tops) yield 0.38% essen. oil containing citronellal 15.7%, l-linalool 10.2%, methyl-cinnamate, citrnellic acid and eugenol (*Perfum. essent. Oil Rec.*, 1938, 402; *Chem. Abstr.*, 1939, 2651); air-dried plant yields 1.85% essen. oil containing 0.84% borneol (*Farmatsiya i Farmakol.*, No. 4, 1937,

17; *Khim. ref. Zh.*, No. 3, 1938; *Chem. Abstr.*, 1939, 5594); average yield of essen. oil 0.7% containing over 68% aldehydes calculated as citral; methyl-heptenone, citronellal, linalool, geraniol and citronellol; a good source of citral (*Proc. nat. Acad. Sci. India*, 1938, 120; *Chem. Abstr.*, 1939, 5992); essen. oil fractionated and following products obtained; dipentene, terpinolene, crithmene, limonene (about 15%), *d*- α -pinene, sabinene, camphene (about 10%), caryophyllene (about 1%), traces of phenol and acetic acid (*Farmatsiya i Farmakol.*, No. 5, 1938, 13; *Khim. ref. Zh.*, No. 11-12, 1938, 158; *Chem. Abstr.*, 1939, 8914); leaves and tender stems yield on average 0.6-0.7% essen. oil containing linalool 10.9, esters 4-8, geraniol and citronellol 7-3, methylheptenone 2.4, citral 60.0 and citronellal 7.3% (*Indian Soap J.*, 1940, 248; *Chem. Abstr.*, 1940, 6015). Plains and lower hills of India.

O. *BASILICUM* Linn. S.—*Munjariki*; H. & B.—*Babuitulsi*; Bo. & Marathi—*Sabza*; Tam.—*Tirnutpachi*; Tel.—*Bhutulasi*; Mal.—*Tirunitru*; P.—*Babri*. Flowers—carmin., diur., stim., demulc. Seeds—mucilaginous, given in infusion in gonorr., dysen., and chr. diar. Root—used in bowel complaints of children. Leaves—useful in treatment of croup, for which the warm juice with honey is given. Essen. oil (*J. Soc. Chem. Ind.*, Lond., 1918, 604; *Chem. Zbl.*, 1911, I, 223; *Ber. Schimmel u. Co., Lpz.*, 1903, April, 33; 1925, 54; 1929, 70; 1934, 51; *Perfum. essent. Oil Rec.*, 1933, 2); fresh flowering herbs yield essen. oil containing alcohols (as linalool) 65.3%, small amount of cineole, eugenol, sesquiterpenes and *d*-terpene (*Amer. Perfum.*, 1935, 69; *Chem. Abstr.*, 1936, 1941); mature plant yields 0.4% essen. oil (*Perfum. essent. Oil Rec.*, 1938, 89; *Chem. Abstr.*, 1938, 4278); leaves yield 0.5% essen. oil containing methyl cinnamate 56.67, *l*-linalool 4.36 and terpinene 80.85% (*Indian Soap J.*, 1946, 210; *Chem. Abstr.*, 1948, 4717); essen. oil from plant during rains and dry season contains 57.14 and 69.66% methyl cinnamate and 20.25 and 11.32% linalool respectively (*Indian J. Pharm.*, 1950, 132; *Chem. Abstr.*, 1950, 8602).^{*} Indigenous to the lower hills of the Punjab. Cultivated throughout the greater part of India.

O. *SANCTUM* Linn. S., Tam., Tel. & Mal.—*Tulasi*; H. & B.—*Tulsi*; Bo.—*Tulasa*. Leaves—expect. Juice of leaves—diaphor., antiper. and stimulating expect.; used in catarrh and bronch.; dropped into the ear as remedy for earache. Infusion of leaves—used as stomach. in gastric disorders of children and in hepatic affections. Dried leaves—powdered and used as snuff in ozaena. Seeds—demulc., given in disorders of the genitourinary system. Root—given in decoct. as a diaphor. in malarial fevers. Fresh roots, stems and leaves—bruised and applied to the bites of mosquitoes. Plant—in snake-bite and scorpion-sting. Essen. oil (*Ber. Schimmel u. Co., Lpz.*, 1911, April, 87; 1912, April, 95); leaves yield 0.7% essen. oil containing 71.3% eugenol, 3.2% carvacrol, 20.4% methyl eugenol and 1.7% caryophyllene; used as an expect., antisept. and insect repellent (*Proc. Indian Acad. Sci.*, 1939, 9A, 72; *Chem. Abstr.*, 1940, 6015). Throughout India, cultivated but doubtfully indigenous.

ONOSMA (*Boraginaceae*)

O. *BRACEATUM* Wall. B. & Urdu—*Gaozaban*; H.—*Shankhahuli*. Plant—tonic, alter., in decoct. much used in rheumatism, syphilis, and leprosy; good refriger. and demulc., useful for relieving excessive thirst and restlessness in febrile excitement and also useful in relieving functional palpitation of the heart, irritation of the bladder and stomach, and strangury. Kashmir and Kumaon at 11,500 ft.

OPERCULINA (*Convolvulaceae*)

O. *TURPETHUM* (Linn.) Silva Manso syn. *Ipomoea turpethum* R. Br. B.—*Dudh kalmi*; P.—*Nisot*; Bo.—*Nisholar*; H.—*Nisoth*; S.—*Tripata*; Tam.—*Sivadai*; Tel.—*Tellate-gadda*; Mal.—*Rochani*. Root—purg., prescribed in scorpion-sting and snake-bite. Resin—similar to jalap resin. Glucid., turpethin (*Liebigs Ann.*, 1866, 41; Wehmer, II, 1009). Throughout India up to 3,000 ft.; also occasionally grown in gardens.

ORIGANUM (*Labiatae*)

O. *MAJORANA* Linn.; see *MAJORNA HORTENSIS* Moench.

OROXYLUM (*Bignoniaceae*)

O. INDICUM Vent. S.—*Shyonaka*; H.—*Arlu*; B.—*Sona*; Bo.—*Tetu*; Tam.—*Vangam*; Tel.—*Mokkavepa*; Mal.—*Aralu*; P.—*Tatmorang*. Root bark—astrin., tonic, useful in diar. and dysen. Bark—made into powder along with *haldi* useful cure for sore-backs of horses; in powder or infusion diaphor., useful in acute rheumatism; bitter tonic. Tender fruits—grateful carmin., stomch. Seeds—purg. Stem—in scorpion-sting. Crystalline bitter oroxylin; alk. (*J. chem. Soc.*, 1901, 354); glucd. bitter substance (Dragendorff-Heilpflanzen, 609; *Proc. chem. Soc., Lond.*, 1901 148); crystalline substance oroxylin separated from bark and seeds and baicalein from bark (*J. chem. Soc.*, 1936, 591; 1938, 1555).* Throughout India, except in the western drier area.

ORYZA (*Gramineae*)

O. SATIVA Linn. S.—*Dhanya*, *Shali*; H. & B.—*Chaval*, *Dhan*; Marathi—*Tandula*; Tam.—*Arishi*; Tel.—*Dhanyamu*; Mal.—*Ari*; Bo.—*Bhatta*. Rice gruel—in disorganized digestion, in bowel complaints, in diar. and dysen. Rice-water—demulc., refrig., soothing, nourishing drink in febrile diseases and inflammatory states of intestines. Rice poultice—used like linseed meal poultice. (*J. Amer. chem. Soc.*, 1903, 948; *J. chem. Soc.*, 1923, 2666); alk. oridine (antineuritic when impure) (*Biochem. Z.*, 1920, 218); As—7 mg. in 100 g. ash of corn (*C.R. Acad. Sci., Paris*, 1912, 893; 1914, 269; *Chem. Zbl.*, 1912, I, 1730; 1914, II, 885; *J. Physiol.*, 1912, 75, 395; *Biochem. J.*, 1914, 598; *Chem. Zbl.*, 1923, I, 1192; 1920, III, 14; 1927, I, 1850); silver skin contains oryzyanin, a base (*Bull. agric. chem. Soc., Japan*, 1932, 11; *Chem. Zbl.*, 1932, I, 2071; *Proc. imp. Acad. Japan*, 1932, 179; *Chem. Zbl.*, 1932, II, 2202); bran gave a glucd. nukain which on hydrolysis yielded the aglucone nukagenin (*Chem. Abstr.*, 1950, 3016). Widely cultivated.

PAEDERIA (*Rubiaceae*)

P. FOETIDA Linn. S.—*Prasarani*; H.—*Gandhali*; B.—*Gandhabhadulia*; Bo.—*Prasaram*; Tel.—*Savirela*; Mal.—*Talanili*; Marathi—*Iliranvel*. Plant—considered specific for rheum. affections, administered both internally and externally. Roots—emetic. Juice of leaves—astrin., given to children in diar. Herb contains essen. oil, alk. (Dymock, Warden & Hooper, II, 229).* Central and E. Himalayas, up to 5,000 ft., extending to Calcutta and Malay Peninsula.

PAPAVER (*Papaveraceae*)

* P. SOMNIFERUM Linn.

PEDALIUM (*Pedaliaceae*)

P. MUREX Linn. H. & B.—*Baragokhru*; Bo.—*Motloghokru*; Tam.—*Perunerunji*; Tel.—*Yenugapalleru*; Mal.—*Katunerinjal*. Fruit—demulc., diur., antisp., aphrodis.; in decoct. given for incontinence of urine, spermatorrhoea, nocturnal emission and impotency. Infusion of leaves and stems—used in gonorr. and dysuria. Juice of fruit—emmen., used in puerperal diseases and to promote lochial discharges. Decoct. of root—antibil. Young branches contain mucil. and root alk. (Dymock, Warden & Hooper, III, 36). Kathiawar, Gujarat, Konkan, Deccan Peninsula.

PEGANUM (*Zygophyllaceae*)

* P. HARMALA Linn.

PENTAPETES (*Sterculiaceae*)

P. PHOENICEA Linn. S.—*Bandhuka*; H.—*Dopahari*; B.—*Bandhuli*; Bo. & Marathi—*Tambhidupari*; P.—*Guldupaharia*; Tam.—*Nagappu*. Plant—emol., demulc., used in snake-bite. Fruit—mucilaginous. Indigenous to N.W. India, Bengal, Gujarat, planted in many places.

PENTATROPIS (*Asclepiadaceae*)

P. CYNANCHOIDES R. Br. P.—*Vanveri*; Bo.—*Singarota*; H.—*Kauathodi*; S.—*Kakakshi*. Dry roots—given in decoct. as astrin. and cooling alter., used in gonorr. Punjab, eastwards to the Jumna, Baluchistan and Sind.

P. MICROPHYLLA W. & A. H.—*Ambarvel*; S.—*Shringariti*; Mal.—*parpparam*; Tam.—

Uppili; Tel.—*Pulapala*; Marathi—*Shingrota*. Plant—cooling, alter. Bengal and Western Peninsula.

PERISTROPHE (*Acanthaceae*)

P. *BICALYCVLATA* Nees. H.—*Atrilal*; B.—*Nasabhaga*; Bo.—*Pit-papra*; Tel.—*Chebira*. Plant—macerated in an infusion of rice said to be antid. to snake poison. Throughout India.

PEUCEDANUM (*Umbelliferae*)

* P. *GRAVEOLENS* Linn.

PHASEOLUS (*Leguminosae*)

P. *RADIATUS* Linn. S.—*Masha*; H.—*Urid*; B.—*Mashkalai*; Bo.—*Udid*; M.—*Ulundu*; P.—*Mash*; Mal.—*Cherupoyara*; Tam.—*Paunippayaru*; Tel.—*Patchapsalu*. Seeds—used both internally and externally, in paralysis, rheumatism and affections of the nervous system, considered hot and tonic, useful in piles, affections of the liver and cough, and in fever. Root—narcotic. (*J. Amer. chem. Soc.*, 1897, 509; *J. biol. Chem.*, 1922, 103); seeds contain saponin I, II and III (*J. pharm. Soc. Japan*, 1932, 33; *Chem. Zbl.*, 1932, I, 3185). Extensively cultivated all over India.

PHOENIX (*Palmae*)

P. *DACTYLIFERA* Linn. H., P., B. & Bo.—*Khajur*; S.—*Pinda-kharjura*; Tam.—*Perichum*; Tel.—*Kharjuramu*; Mal.—*Tenitta*. Fresh juice—cooling, laxt. Gum—useful in diar. and diseases of the genito-urinary system. Fruit—demulc., expect., nutrient, laxt., aphrodis., prescribed in asthma, chest complaints and cough; also in fever, gonorr. etc. Vitamin B and antiscor. vitamin; fruit contains vitamin A, B and D (*Bull. Soc. bot.*, 1933, 388; *Chem. Zbl.*, 1933, II, 3354). Cultivated and self-sown in Sind, and S. Punjab.

P. *SYLVESTRIS* Roxb. S.—*Kharjuri*; H., P., B. & Bo.—*Khajur*; Tam.—*Periyaitcham*; Tel.—*Peddayita*; Mal.—*Kattinta*. Fruit—tonic and restor. Juice of tree—used as a cooling beverage. Root—used in toothache. Kernels—made into a paste with the root of *Achyranthes aspera*, eaten with betel leaves as remedy for ague. Tolerably common throughout India, wild or more often cultivated.

PHRAGMITES (*Gramineae*)

P. *MAXIMA* Blatter & McCann. B. & P.—*Nal*; H.—*Narkul*; S.—*Nala*; Tam.—*Perunanal*; Tel.—*Peddarellu*; Mal.—*Nalam*. Root—regarded as cooling, diur. and diaphor. Throughout India, ascending the Himalayas in hot valleys to 3,000 ft.

PHYLLANTHUS (*Euphorbiaceae*)

P. *EMBLICA* Linn.; see *EMBLICA OFFICINALIS* Gaertn.

P. *NIRURI* Linn. S.—*Bhumyamalaki*; H.—*Jar-amlā*; B.—*Bhui-amlā*; Bo.—*Bhui-avala*; Mal.—*Kizh-kkayinelli*; Tam.—*Kilkkayinelli*; Tel.—*Nelavusari*. Plant—used as a diur. in dropsical affections, gonorr. and other troubles of the genito-urinary tract. Infusion of young shoots—given in dysen. Fresh root—remedy for jaundice. Leaves—stomch. Milky juice—used as application to offensive sores. Powdered leaves and roots—pulverized and made into poultice with rice-water used to lessen oedematous swellings and ulcers. Leaves contain bitter substance phyllanthin (*Ber. dtsch. pharm. Ges.*, 1905, 186); a popular remedy against fever; neither quinine nor any alk. detected (*An. Univ. S. Domingo*, 1944, 295; *Chem. Abstr.*, 1947, 1812); dry leaves yield bitter principles hypophyllanthin (0.05%) and phyllanthin (0.35%); toxic to fish and frog (*Proc. Indian Acad. Sci.*, 1946, 24A, 357; *Chem. Abstr.*, 1947, 2712). Throughout the hotter parts of India from the Punjab to Assam and southwards to Travancore, ascending the hills to 3,000 ft.

P. *URINARIA* Linn. S.—*Tamravalli*; Marathi—*Lalmundajanvali*; H. & B.—*Hazarmani*; Mal.—*Chirukishukanelli*; Tel.—*Ettasirika*; Tam.—*Shivappunelli*. Plant—used as diur. in dropsical affections, also in gonorr. and other genito-urinary troubles; fish poison. Root—given to sleepless children. Alkaloidal principles (Dymock, Warden & Hooper,

I-III). Throughout the plains of India from the Punjab to Assam and Madras State up to 3,000 ft.

PICRORHIZA (*Scrophulariaceae*)

* P. KURROA Royle ex Benth.

PIMPINELLA (*Umbelliferae*)

* P. ANISUM Linn.

PINUS (*Pinaceae*)

P. DEODARA Roxb.; see CEDRUS DEODARA (Roxb.) Loudon.

P. ROXBURGHII Sargent syn. *P. longifolia* Roxb. S. & Tel.—*Sarala*; H. & P.—*Chir*; B.—*Saralagachha*; Marathi—*Saraladeodara*; Tam.—*Simaidevadari*; Mal.—*Saralam*; Kash.—*Sarl*. Resin—stim., stomch., remedy for gonorr. Wood—stim., diaphor. Wood and oleo-resin—used in snake-bite and scorpion-sting. Essen. oil (*J. Chem. Soc.*, 1920, 570; *J. Indian Inst. Sci.*, 1928, 200A); α - and β -carene (*Bull. Inst. Pin.*, 1932, 142; *Chem. Zbl.*, 1932, II, 2249; *Schimmel Ber.*, 1932, 65); contains 40% α - and β -pinene (*J. Indian Inst. Sci.*, 1941, 201; *Chem. Abstr.*, 1942, 4967). Outer Himalayan Ranges from the Indus to Bhutan, 1,600-7,500 ft.

PIPER (*Piperaceae*)

P. CHABA Hunter. S.—*Chavika*; H.—*Chab*; B.—*Choi*; Bo.—*Kankala*; Gujarati—*Chavaka*; Tel.—*Sevasu*. Fruit—arom., stim., carmin., used in cough and cold and in haemorrhoidal affections. Cultivated in various parts of India.

* P. CUBEBA Linn. f.

P. LONGUM Linn. S.—*Pippali*; P., H., B. & Bo.—*Piplamul*; Mal.—*Pippali*; Tel.—*Pippallu*. Dried unripe fruit—alter., tonic. Decoct. of immature fruit and root—used in chr. bronch., cough and cold. Root and fruit—antid. to snake-bite and scorpion-sting. Hotter States of India.

P. NIGRUM Linn. S.—*Maricha*; Tam.—*Milagu*; Mal.—*Kurumulaka*; Tel.—*Marichamu*; H.—*Golmirch*; B.—*Golmorich*; Bo.—*Kala miri*. Fruit—used as arom. stim. in cholera, in weakness following fevers, vertigo, coma; as stomch. in dyspep. and flatulence; as antiper. in malarial fever; as an alter. in paraplegia and arthritic diseases; externally used as rubft. and as a local application for relaxed sore-throat, piles and skin diseases. Alk., chavicine, piperine, piperidine, essen. oil (U.S.D., 1546; *Helv. chim. acta*, 1927, 593; *Amer. J. Pharm.*, 1908, 1; *Ber. Schimmel u. Co., Lpz.*, 1890, Oct., 39); fruits contain piperetine (*J. chem. Soc.*, 1950, 1177; *Chem. Abstr.*, 1950, 10685). Cultivated in hot and damp parts of India.

PISTACIA (*Anacardiaceae*)

* P. INTEGERRIMA Stew. ex Brandis.

P. LENTISCUS Linn. H.—*Rumi mastiki*; B.—*Rumi-mastungi*. Resinous exudation—used in solution as a filling for carious teeth. Resin, essen. oil (*Arch. Pharm., Berl.*, 1904, 104; *Chem. News*, 1896, 120; *Ber. Schimmel u. Co., Lpz.*, 1915, 36; *Pharm. Acta Helvet.*, 1934, 19; U.S.D., 664). Mediterranean region.

PLANTAGO (*Plantaginaceae*)

* P. OVATA Forsk.

PLUCHEA (*Compositae*)

P. LANCEOLATA Oliver & Hiern. P.—*Marinandai*; Gujarati—*Rashana*; Cawnpore—*Sorahi*; Bo.—*Kura-sanna*; S.—*Rasna*. Leaves—aper., subst. for senna. Sind, Punjab, Gangetic Plain as far as Cawnpore.

PLUMBAGO (*Plumbaginaceae*)

* P. INDICA Linn. syn. *P. rosea* Linn.

* P. ZEYLANICA Linn.

POA (*Gramineae*)

P. CYNOSUROIDES Retz.; see DESMOSTACHYA BIPINNATA Stapf.

POLYALTHIA (*Annonaceae*)

* P. LONGIFOLIA Benth. & Hook. f. H. & B.—*Devdaru*; Bo.—*Asoka*; Kan.—*Putrajivi*; M.—

Nettilingam; Mal.—*Ashokam*; Tam.—*Asogam*; Tel.—*Asohanu*. Bark—febrige. Cultivated throughout the hotter parts of India.

PONGAMIA (*Leguminosae*)

* P. GLABRA Vent.; see P. PINNATA (Linn.) Merr.

PORTULACA (*Portulacaceae*)

P. OLERACEA Linn. S.—*Lonika*; H.—*Khursa*, *Kulfa*; B.—*Baraloniya*; Bo.—*Kursah*; M.—*Pasalai*; Mal.—*Koricchira*; Tam.—*Pulikkirai*; Tel.—*Pappukura*. Herb—refrig., alter., useful as an article of diet in scurvy and liver disease. Seeds—vermifuge. Juice of stems—applied to prickly heat and to the hands and feet when a burning sensation is felt. All over India, up to 5,000 ft. in the Himalayas.

PREMNA (*Verbenaceae*)

P. HERBACEA Roxb. S.—*Bhumjambu*; H.—*Bharangi*; B.—*Bamanhati*; Marathi—*Gantubharangi*; Tam.—*Sirudekku*; Tel.—*Kuranelli*. Root preparation—given internally for rheumatism. Plant—used in scorpion-sting and snake-bite. Subtropical Himalayas, 500-3,000 ft., from Kumaon to Bhutan, N. Circars, W. Ghats of Madras State.

P. INTEGRIFOLIA Linn. S.—*Ganakasika*; H. & Bo.—*Arni*; B.—*Baniari*; Mal.—*Munna*; Tam.—*Munmai*; Tel.—*Karnika*. Decoct. of root—cordial, stomach, good for liver complaint. Decoct. of plant—used in rheumatism and neuralgia. Leaves—rubbed along with pepper administered in colds and fevers; in decoct. given for flatulence; in form of soup used as stomach, and carmin. Stem bark contains alk. premnine; decreases force of contraction of heart and produces dilation of the pupils; another alk. ganiarine; (*J. Amer. pharm. Ass.*, 1947, 389; *Chem. Abstr.*, 1948, 3535). Near the sea from Bombay to Malacca, Ceylon, and the Andamans.

PROSOPIS (*Leguminosae*)

P. SPICIGERA Linn. B. & Bo.—*Shami*; H.—*Jhand*; P.—*Jand*; S.—*Shami*; Tam.—*Kalisam*; Tel.—*Jammi*; Mal.—*Parampu*. Pod—astrin. Bark—used as remedy in rheumatism and scorpion-sting. Flowers—pounded and mixed with sugar eaten by women during pregnancy as a safeguard against miscarriage. Ashes—rubbed over the skin to remove hair. Punjab, Rajasthan, Bundelkhand, Gujarat, Sind, and Baluchistan.

PRUNUS (*Rosaceae*)

P. AMYGDALUS Batsch syn. *P. communis* Arcang.; *P. amygdalus* Baill.; *Amygdalus communis* Linn. H., P., M. & Bo.—*Badam*; B.—*Bilati-badam*; S.—*Badama*; Tam.—*Vadumai*; Tel.—*Badamu*. Seeds—demulc., stim., nervine tonic. HCN-glucd., As 0.025 mg. in 100 g. fruit (*C.R. Acad. Sci., Paris*, 1912, 893; *Chem. Zbl.*, 1912, I, 1730; *J. chem. Soc.*, 1909, 927; *Arch. Pharm., Berl.*, 1908, 206, 509; 1909, 226, 542; 1910, 101; 1925, 563; *Ber. deutsch. chem. Ges.*, 1923, 857)*. Cultivated in the cooler parts of Punjab and Kashmir.

P. CERASOIDES D. Don syn. *P. puddum* Roxb. ex Wall. S. & Marathi—*Padmaka*; H. & Kumaon—*Paddam*; Bo.—*Padmakasta*. Smaller branches—used as subst. for hydrocyanic acid. Kernel—used in stone and gravel. Amygdalin (*Arch. Pharm., Berl.*, 1906, 398); prunasetin (isoflavone), sakuranetin (*Sci. & Cult.*, 1942-43, 463, 498); puddumetin (flavone) (*J. Indian chem. Soc.*, 1945, 301; 1949, 329). Wild in the temperate Himalayas from Garhwal at 3,000-6,000 ft. to Sikkim and Bhutan from 5,000 to 8,000 ft., Kodaikanal, Ootacamund. Often cultivated.

P. MAHALEB Linn. Bo.—*Gavala*; S.—*Priyunger*. Kernels—used as subst. for hydrocyanic acid, tonic, in scorpion-sting. Coumarin, salicylic acid, amygdalin (*Liebigs Ann.*, 1851, 83; 1852, 243; *Chem. Zbl.*, 1905, II, 1503). Cultivated in Baluchistan. Probably also occurs in N.W. India.

PSIDIUM (*Myrtaceae*)

P. GUAJAVA Linn. S.—*Mansala*; H. & P.—*Amrud*; B.—*Peyara*; Bo.—*Perala*; Tam. & Mal.—*Koyya*; Tel.—*Goyya*. Bark of root—astrin., used in diar. of children. Fruit—laxt. Leaves—used as astrin. for bowels and for wounds and ulcers; their decoct. used in

cholera for arresting vomiting and diar. Leaves contain essen. oil, eugenol (*Chem. & Drugg.*, 1905, 14). Cultivated and naturalized throughout India.

PSORALEA (*Leguminosae*)

* **P. CORYLIFOLIA** Linn.

PTEROCARPUS (*Leguminosae*)

P. MARSIPIUM Roxb. H.—*Bijasar*; B.—*Pitsal*; Bo.—*Bibla*; S.—*Pitasara*; Mal.—*Karintakara*; Tam.—*Pira saram*; Tel.—*Vengisa*. Gum—a good astrin. in diar. and pyrosis, used for toothache. Bruised leaves—useful external application to boils, sores and skin diseases. Bark—astrin. Yields gum kino, which contains kino-tannic acid (*J. chem. Soc.*, 1911, 1530; *Pharm. J.*, 1900, 226; 1903, 840; U.S.D., 608). Western Peninsula and S. India.

P. SANTALINUS Linn. f. B. & S.—*Raktachandana*; Bo.—*Raktachandan*; H.—*Lalchandan*; Mal.—*Raktashandanam*; Tam.—*Sensandanam*; Tel.—*Raktachandanamu*. Wood—astrin. tonic, used as cooling external application for inflam. and headache, in bilious affections and skin diseases, in fever, boils, and to strengthen the sight, diaphor., in scorpion-sting. Fresh shoots yield glucd., colouring matter (*J. chem. Soc.*, 1912, 1061; *Arch. Pharm., Berl.*, 1929, 81; *Ber. dtsh. chem. Ges.*, 1934, 1403; *Chem. Zbl.*, 1934, II, 2681; U.S.D., 973) Deccan, in the hills of Cuddapah, S. Kurnool, N. Arcot and Chingleput, up to 1,500 ft.

PUNICA (*Punicaceae*)

P. GRANATUM Linn. S.—*Dadima*; H.—*Anar-ke-per*; P.—*Anar*; B.—*Dalimgachh*; Bo.—*Dalimba*; Tam.—*Madalai*; Tel.—*Dalimma*; Mal.—*Dadiman*; Assam—*Dalim*. Root bark and stem bark—astrin., anthelm., specific in tapeworm. Kind of fruit—combined with aromatics like cloves, etc., useful in diar. and dysen. Seeds—stomch. Pulp—cardiac, stomch. Fresh juice—cooling, refriger. Bark yields alk. pelletierine, etc. (*Arch. Pharm., Berl.*, 1899, 49; *Ber. dtsh. chem. Ges.*, 1917, 368; 1919, 1005); root bark contains four alks., pseudo-pelletierine, pelletierine, isopelletierine, and methylpelletierine (Henry, 1949, 55; U.S.D., 828)* Wild in the Salt Range and in the Himalayas from 3,000 to 6,000 ft., and cultivated in many parts of India.

PUTRANJIVA (*Euphorbiaceae*)

P. ROXBURGHII Wall. S., H. & B.—*Putranjiva*; P.—*Jivaputra*; Bo. & Kan.—*Putrajiva*; Mal.—*Pongalam*; Tam.—*Karupali*; Tel.—*Kudurujiivi*. Leaves, fruits and stones of fruits—given in decoct. in colds and fevers. Throughout tropical India, wild and cultivated.

QUERCUS (*Fagaceae*)

Q. INFECTORIA Oliv. S., H. & B.—*Majuphal*; Bo.—*Maiphal*; M.—*Mashikkay*. Bark and acorns—astrin., used in intertrigo, impetigo, eczema. Galls contain ellagic acid; main constituent of tamin is pentadigalloyl-glucose (*J. Chem. Soc.*, 1897, 1131; *Chemikerztg.*, 1908, 918; *Ber. Dtsch. Chem. Ges.*, 1914, 2485; *Liebigs Ann.*, 1923, 288; Wehmer, I, 222)* Greece, Asia Minor, Syria.

RANDIA (*Rubiaceae*)

* **R. DUMETORUM** Lam.

RAPHANUS (*Cruciferae*)

R. SATIVUS Linn. S.—*Mulaka*; H. & P.—*Muli*; B. & Bo.—*Mula*; Tam., Tel. & Mal.—*Mullangi*. Juice of fresh leaves—diur., laxt. Seeds—expect., peptic, diur., laxt., carmin. Roots—used for urinary complaints, piles and gastrodynic pains. Seeds yield essen. oil; As 0.01 mg. in 100 g. root (*C.R. Acad. Sci., Paris*, 1912, 893; *Chem. Zbl.*, 1912, I, 1730; Dymock, Warden & Hooper, I, 129); roots contain glucd., enzyme and methyl mercaptan (*Biochem. Z.*, 1926, 31)* Cultivated all over India up to 16,000 ft.

RAUWOLFIA (*Apocynaceae*)

* **R. SERPENTINA** Benth. ex Kurz.

RHEUM (*Polygonaceae*)

* R. EMODI Wall.

RHUS (*Anacardiaceae*)

R. SUCCEDANEA Linn. S.—*Karkata sringi*; H.—*Kakrasingi*; Bo.—*Takadasingi*; B.—*Kakrasingi*; Kan.—*Karkatakashringi*; Tam.—*Karkkadagachingi*; Tel.—*Karkkarasringi*; P.—*Arkhol*; Khasia—*Dingkain*. Thorn-like excrescences on the branches—astrin, given to children suffering from diar. and dysen. Juice of leaves—blisters the skin. Fruit—used in treatment of phthisis. Fruits yield Japan wax, leaves contain tannin (Wehmer, II, 709; *Ber. Dtsch. Chem. Ges.*, 1907, 4784; *Arch. Pharm., Berl.*, 1909, 650; *Bull. Soc. Chim. Paris*, 1911, 608; *C.R. Acad. Sci., Paris*, 1932, 405); milky juice yields laccol which is identical with urushiol (U.S.D., 1499). Temperate Himalayas from Kashmir, 3,000-6,000 ft., to Sikkim, 5,000-6,000 ft., Bhutan Khasia Hills, 2,000-6,000 ft., and Sind.

RICINUS (*Euphorbiaceae*)

* R. COMMUNIS Linn.

ROSA (*Rosaceae*)

R. ALBA Linn. B.—*Sweet gulab*; H.—*Gulab*; Bo.—*Gul*; Kan.—*Mullusevantige*; P.—*Gulscoti*; S.—*Bhringeshta*. Flowers—used as a cooling medicine in fever and in palpitation of heart. Petals—laxt.* Cultivated in India.

R. CENTIFOLIA Linn. H. & P.—*Golab*; B.—*Golap*; Kan.—*Gulabi*; Mal.—*Gulabapushpam*; S.—*Devataruni*; Tam.—*Irosa*; Tel.—*Roja*. Root—astrin. Petals—laxt., given in form of a syrup to infants. Cultivated in India.

RUBIA (*Rubiaceae*)

R. CORDIFOLIA Linn. B.—*Manjistha*; H., Bo. & P.—*Manjit*; S.—*Manjistha*; Tam.—*Manjitti*; Tel.—*Manjishatige*; Mal.—*Manjetti*. Root—tonic, alter., astrin. Stem—used in cobra-bite and scorpion-sting. Glucd. munjistin (*J. Chem. Soc.*, 1893, 1157). Throughout India in hilly districts.

RUNGIA (*Acanthaceae*)

R. REPENS Nees. Bo.—*Ghatipitapada*; Gujarati—*Khatsalio*; H.—*Kharmor*; S.—*Parpatha*; Tam.—*Kodagasalai*. Plant—dried and pulverized given in fevers and cough and considered vermifuge. Fresh leaves—bruised and mixed with castor oil applied to the scalp in cases of tinea capitis. Throughout the warmer parts of India.

RUTA (*Rutaceae*)

* R. GRAVEOLENS Linn.

SACCHARUM (*Gramineae*)

S. OFFICINARUM Linn. S., Kan. & Mal.—*Ikshu*; H., P. & B.—*Ganna*; Bo.—*Serdi*; Tam.—*Karumbu*; Tel.—*Cheraku*. Stems—sweet, laxt., diur., cooling, aphrodis. Root—demulc., cooling, diur. Calcium oxalate (*C.R. Acad. Sci., Paris*, 1849, 613).* Cultivated in the hotter parts of India.

S. SPONTANEUM Linn. B.—*Kash*; H.—*Kans*; P.—*Kahi*; Tam.—*Nanal*; Tel.—*Kakicheraku*; Mal.—*Nannana*; S.—*Kasha*. Plant—laxt., aphrodis., useful in burning sensations, strangury, phthisis, vesical calculi, diseases of blood, biliousness, haemorrhagic diathesis. Throughout India in the warmer parts ascending to 6,000 ft. in the Himalayas.

SALVIA (*Labiatae*)

S. AEGYPTIACA Linn. P.—*Tukhm-malanga*. Seeds—used in diar., gonorr. and haemorrhoids. Plant—used as a cure for eye diseases. Punjab Plains, Sind and Baluchistan.

SANTALUM (*Santalaceae*)

* S. ALBUM Linn.

SAPINDUS (*Sapindaceae*)

S. TRIFOLIATUS Linn. S.—*Phenila*; H., B. & Bo.—*Ritha*; Mal.—*Ponnan-kotta*; Tam.—*Pomangottai*; Tel.—*Phenilamu*. Fruit—tonic, alexipharmac, given internally as expect., emmetic, purg. and nauseant; as an errhine used in epilepsy, asthma, hysteria

and hemicrania; externally it is detergent; used as fish poison. Saponin (*J. Soc. Chem. Ind., Lond.*, 1910, 1431). South and west India round the villages. Cultivated in Bengal. Occasionally planted elsewhere.

SARACA (*Leguminosae*)

* *S. INDICA* Linn.

SAUSSUREA (*Compositae*)

* *S. LAPPA* C. B. Clarke

SCHLEICHERA (*Sapindaceae*)

S. OLEOSA (Lour.) Merr. syn. *S. trijuga* Willd. H.—Kosum; Bo.—Kosam; Kumaon—Kusm; Mal.—Puvam; Tam.—Kolama; Tel.—Posuku. Bark—astrin, rubbed up with oil used as a cure for itch. Powdered seeds—applied to ulcers of animals and for removing maggots. Oil of the seeds—used for the cure of itch and acne; efficient and stimulating agent for the scalp, both cleansing it and promoting growth of hair. Seeds contain cyanogenetic glucd. (*J. Soc. Chem. Ind., Lon.*, 1920, 88; *Analyst*, 1915, 3; *Apothekerztg, Berl.*, 1920, 17; *Pharm. Zentralh.*, 1891, 396; *Amer. Chem. J.*, 1894, 497). * Dry forests of the sub-Himalayan tract from the Sutlej to Nepal, Chota Nagpur, central and southern India; not in Assam.

SCINDAPSUS (*Araceae*)

S. OFFICINALIS Schott. H. & B.—Gajapipal; Bo. & Marathi—Thorapimpli; S.—Gajapippali; Mal.—Attittippali; Tam.—Anaitippili; Tel.—Enugatippali. Fruit—aphrodis., stim., diaphor., anthelm., applied externally for rheumatism. Alk. (Dymock, Warden & Hooper, III, 544). * Tropical Himalayas, from Sikkim eastwards, Bengal, Chittagong and the Andaman Islands.

SCIRPUS (*Cyperaceae*)

S. GROSSUS Linn. f. S.—Kaseruka; H. & B.—Kasuru; Bo.—Kachera; P.—Kaseru. Tubers given in diar. and vomiting. Amylase from the fruit (*J. Indian Chem. Soc.*, 1941, 407). More or less throughout India.

SEMECARPUS (*Anacardiaceae*)

* *S. ANACARDIUM* Linn. f.

SESAMUM (*Pedaliaceae*)

* *S. INDICUM* Linn. syn. *S. orientale* Linn.

SESBANIA (*Leguminosae*)

S. GRANDIFLORA (Linn.) Pers. S.—Agasti; H. & Bo.—Basna; B.—Bak; Tam.—Agatti; Tel.—Agise; Mal.—Akatti. Bark—astrin, tonic, an infusion given in small-pox. Juice of leaves or flowers—used as a remedy for nasal catarrh and headache. Ash analysis and composition (*Chem. Zbl.*, 1909, II, 649). Plains of Western Peninsula.

SHOREA (*Dipterocarpaceae*)

S. ROBUSTA Gaertn. f. S.—Sala; H., P., B. & Bo.—Sal; Tam.—Kungiliyam; Tel.—Sarjakamu; Mal.—Mulappamarutu. Resin—astrin, detergent, used in dysen., artd for fumigations and plasters; given for weak digestion, gonorr. and as aphrodis. Resin contains essen. oil 62% (*Indian Soap J.*, 1946, 77; *Chem. Abstr.*, 1948, 3536). Kangra district of the Punjab, from the Kalesar forest in the Ambala district along the sub-Himalayan tract to the Darrang district of Assam, sometimes in the outer Himalayan valleys up to 5,000 ft.; Garo Hills, from the Santal Parganas through Chota Nagpur and Orissa to Ganjam, Jeypore, Madhya Pradesh, and Vizagapatam.

SIDA (*Malvaceae*)

* *S. CORDIFOLIA* Linn.

SMILAX (*Liliaceae*)

S. CHINA Linn. S., H., B. & Bo.—Chobchini; M.—Paringay. Root—aphrodis., sudorific, demulc., alter., used in chr. rheumatism, syphilis and skin diseases. Saponin (Wehmer, I, 162). Japan, China and Cochin China.

SOLANUM (*Solanaceae*)

S. INDICUM Linn. S.—Vanavrintaki; H.—Birhatta; P.—Kandyari; B.—Byakura; Bo.—Ringani; Tam.—Papparamulli; Tel.—Chittimulaga; Mal.—Nilavalutina. Root—carmin.,

expect., useful in asthma, cough, catar. affections, difficult parturition, toothache, fevers, worm complaints, colic, in dysuria and incontinence. Juice of leaves—with fresh juice of ginger taken to stop vomiting. Leaves and fruit—rubbed up with sugar used as external application for itch. Enzyme in fruits (*J. biol. Chem.*, 1934, 675; *Chem. Zbl.*, 1934, II, 2840); alk. solanine, solanidine in roots and leaves (*Indian J. Med. Res.*, 1934, 269; *J. Indian Chem. Soc.*, 1941, 329).^{*} Throughout tropical India.

S. *NIGRUM* Linn. S.—*Kakamach*; B.—*Kakmachi*; H.—*Makoi*; Bo. & P.—*Mako*; Tam.—*Manattakkali*; Tel.—*Kamanchi*. Berries—used in fevers, diar., eye diseases, hydrophobia. Juice of plant—hydragogue cath., diur., alter., given in chr. enlargement of the liver, in blood-spitting, piles, dysen., etc. Young shoots—given in skin diseases and used in psoriasis. Decoct. of leaves—diur., laxt. Alk. solanine, saponin in plant and berries (*Arch. Pharm., Berl.*, 1891, 527; *Pharm. Zentralh.*, 1892, 712; U.S.D., 1593); feeding experiments on sheep for toxicity showed negative results (*Aust. vet. J.*, 1939, 19).^{*} Throughout India, up to 9,000 ft. in the W. Himalayas.

S. *XANTHOCARPUM* Schrad. & Wendl. S. & B.—*Kantakari*; P.—*Kandiari*; H.—*Kateli*; Bo.—*Bhuringni*; Tam.—*Kandangattiri*; Tel.—*Challamulaga*; Mal.—*Kantankattiri*. Root—expect., used in cough, asthma, catar. fever, and pain in chest; beaten up and mixed with wine given to check vomiting. Juice of berries—useful in sore throat. Stem, flowers and fruits—bitter, carmin., prescribed in burning of the feet in cases attended with a vesicular, watery eruption. Plant—used in diur. dropsy; in decoct. used in gonorrhea. Leaves—applied locally to relieve pain; their juice given with black pepper in rheumatism. Bud and flower—with salt solution good for watery eyes. Fruits yield carpesteral and 1.3% gluco-alk. solanocarpine (*Proc. Indian Acad. Sci.*, 1936, 4A, 255; *Chem. Abstr.*, 1937, 805; *J. Amer. chem. Soc.*, 1937, 2467; *Chem. Abstr.*, 1938, 572); fruits yield gluco-alk. solanine-S; on hydrolysis it yields alk. solanidine-S (*J. Mysore Univ.*, 1942, 117; *Chem. Abstr.*, 1943, 1437); glycosidal alk. solanocarpine obtained from the seeds believed to be identical with solanine-S (*J. Amer. chem. Soc.*, 1937, 1404; U.S.D., 1594).^{*} Throughout India.

SOYMIDA (*Meliaceae*)

S. *FERRIFUGA* A. JUSS. S.—*Rohini*; H.—*Rohun*; B. & Bo.—*Rohan*; Tam.—*Somadanam*; Tel.—*Somida*; Kan.—*Sunbi*. Bark—astrin., bitter tonic, febrifuge, used in general debility, intermittent fevers, diar. and dysen. Bark contains bitter substance (*Arch. Pharm. Berl.*, 1851, 271; U.S.D., 1616). Dry forests of the W. Peninsula, extending northwards to Marwar, the Mirzapur hills and Chota Nagpur.

SPHAERANTHUS (*Compositae*)

S. *INDICUS* Linn. S.—*Mundirika*; H.—*Mundi*; Bo.—*Gorakhmundi*; B.—*Murmura*; Tam.—*Kottakkarandai*; Tel.—*Bodasoram*; Mal.—*Attakkamanni*. Herb—tonic, deobstruent, alter., aphrodis. Root and seed—anthelm. Flowers—alter., cooling, tonic. Decoct. of plant—used as a diur. in urethral discharges. Rind of fruit—used as a fish poison. Essen. oil in herb. alk. in leaves, stems and flowers (Dymock, Warden & Hooper, II, 258; *Pharm. J.*, 1884, 985); contains alk. sphaeranthine; fresh flowering plant yields essen. oil (*J. Amer. pharm. Ass.*, 1946, 274; *Chem. Abstr.*, 1947, 566).^{*} Throughout India ascending the Himalayas up to 5,000 ft., from Kumaon to Sikkim.

SPONDIAS (*Anacardiaceae*)

S. *PINNATA* Kurz syn. *S. mangifera* Willd. S.—*Amrataka*; H., B. & Bo.—*Amra*; Tam.—*Mambulichi*; Tel.—*Amratakamu*; Mal.—*Mampuli*; Kan.—*Ambate*. Bark—refrig., useful in dysen.; ground and mixed with water rubbed on in both articular and muscular rheumatism. Fruit—antiscor. and the pulp astrin., used in bilious dyspepsia. Juice of leaves—used in earache. (Wehmer, II, 704; *Chemikerztg.*, 1897, 719). Sub-Himalayan tract and outer valleys up to 3,000 ft., from the Chenab eastwards, Salt Range, Andamans and W. Peninsula.

STERCULIA (*Sterculiaceae*)

S. *URENS* Roxb. M.P. & Bo.—*Gulu*; H.—*Karrai*; Kan.—*Bhutali*; Konkani—*Pandruk*; Mal.

—*Tonti*; Tam.—*Vellaiputtali*; Tel.—*Ponaku*. Gum—used as subst. for tragacanth; used in throat affections. Leaves and tender branches—when steeped in water yield a mucilaginous extract useful in pleuro-pneumonia in cattle. Gujarat, Konkan, Deccan, N. Kanara, S. Mahrata Country, dry forests of the Madras State, Rajasthan, N. and Central India, and Chota Nagpur. Throughout India.

STEREOSPERMUM (*Bignoniaceae*)

S. TETRAGONUM DC. syn. *S. chelonoides* DC. H.—*Pader*; B.—*Dharmar*; Bo.—*Padal*; S.—*Patoli*; Kan.—*Kaludi*; Mal.—*Karinkara*; Tam.—*Kural*; Tel.—*Kaligottu*. Root, leaves and flowers—used in decoct. as a febrige. Juice of leaves—mixed with lime juice used in maniacal cases. Flower and fruit—in scorpion-sting. Bark contains crystalline bitter substance (*Meded. PlTuin, Batavia*. 1897, 39; 1899, 136). Throughout moist regions of India.

STREBLUS (*Moraceae*)

S. ASPER Lour. S.—*Shakhotaka*; H.—*Siora*; B.—*Sheora*; Bo.—*Karvati*; Mal.—*Paruva*; P.—*Dahya*; Tam.—*Piray*; Tel.—*Barinika*. Decoct. of bark—given in fever, dysen., and diar. Roots—used as application to unhealthy ulcers and sinuses; antid. to snake-bite. Milky juice—antisept., astrin., applied to chapped hands and sore heels. Bark contains bitter substance (*Ned Tijdschr. Pharm. Chem. Toxic.*, 1896, 204). Drier parts of India, from Rohilkhand, eastwards and southwards to Travancore and Andaman Islands.

STRYCHNOS (*Loganiaceae*)

* S. NUX-VOMICA Linn.

S. POTATORUM Linn. f. S.—*Kataka*; H., P., B. & Bo.—*Nirmali*; Tam.—*Tetankottai*; Tel.—*Katakamu*; Mal.—*Katakam*. Seeds—used as a local application in eye diseases; rubbed with honey and little camphor, the mixture applied to the eyes in lachrymation or copious watering; used as emetic in dysen., in diabetes and gonorr. Brucine (*Arch. Pharm., Berl.*, 1892, 549; U.S.D., 1609). Konkan, N. Kanara, Madhya Bharat, N. Circars, Deccan, Carnatic to S. Travancore.

STYRAX (*Styracaceae*)

S. BENZOIN Dryand. H., B. & Bo.—*Luban*, M.—*Shambirani*. Balsamic resin—external antisept., stimulating expect. (*Parfum. mod.*, 1925, 117, 143; *Pharm. Weekbl.*, 1936, 374; U.S.D., 147)* Malacca and Malaya.

SWERTIA (*Gentianaceae*)

* S. CHIRATA Buch.-Ham.

TACCA (*Taccaceae*)

T. ASPERA Roxb. B., H. & S.—*Varahikanda*; Marathi—*Dukarkanda*. Tuber—tonic, useful in haemorrhagic diathesis, skin diseases and leprosy. Chittagong.

TAMARINDUS (*Leguminosae*)

T. INDICA Linn. S.—*Tintrini*; H., P. & Bo.—*Imli*, *Amlī*; B.—*Tentul*, *Ambli*; Tam.—*Amilam*; Tel.—*Amlīka*; Mal.—*Amlam*. Fruit—refrig., digest., carmin., laxat., useful in diseases caused by deranged bile; their infusion employed as a drink in febrile diseases. Fruit contains trace of oxalic acid (*Chem. Zbl.*, 1905, II, 1042; 1923, II, 1170; *Hoppe-Seyl. Z.*, 1923, 80; U.S.D., 1180). Cultivated throughout India; self-sown in waste places and forest lands in Madhya Pradesh, Madhya Bharat and S. India.

TAXUS (*Taxaceae*)

T. BACCATA Linn. H., Kash. & P.—*Birmi*; B.—*Bhirmie*; Bo.—*Barmi*; Khasia—*Dingsableh*; Kumaon—*Thuner*; Bushahr—*Arkhan*. Leaves and fruits—emmen., sedative, antisp. Leaves—used in asthma, bronchit., hiccuph, for indig. and epilepsy, as an aphrodis. Plant—poisonous, used as fish poison. Alk. taxine, the toxic principle contained in leaves, shoots and seeds, (*J. Chem. Soc.*, 1902, 874; 1931, 2138; *Hoppe-Seyl. Z.*, 1921, 240; *J. Pharm. Soc. Japan*, 1922, 1074); leaves contain alk. taxine, taxinine, traces of ephedrine (*J. Pharm. Soc. Japan*, 1931, 37; *Chem. Zbl.*, 1931, II,

1867; *J. Chem. Soc.*, 1931, 2148); alkaloidal content maximum during winter; alk. taxine is vigorously active heart poison (*Dtsch. ApothZtg*, 1937, 1265; *Chem. Abstr.*, 1938, 723); yields a glucd. taxicatin (*Arch. Pharm., Berl.*, 1943, 205; *Chem. Abstr.*, 1944, 5883); in rabbits the lethal intravenous dose of taxine is between 2 and 3 mg. per kilo and it is depressant both to heart and to respiration (*Quart. J. Pharm.*, 1932, 205; U.S.D., 1623). Temperate Himalayas at 6,000-11,000 ft. and Khasia Hills at 5,000 ft.

TECOMELLA (*Bignoniaceae*)

T. UNDULATA (G. Don) Seem. H. & Bo.—*Rugtrora*; Marathi—*Rakhtreora*; P.—*Rohira*; S.—*Rohi*. Bark of young branches—used as a remedy for syphilis. Punjab, Sind Waziristan, Baluchistan, Rajasthan, Kathiawar, Gujarat and the Deccan.

TERMINALIA (*Combretaceae*)

* T. ARJUNA W. & A.

T. BELERICA Roxb. S.—*Bahira*; H., P. & B.—*Bahera*; Bo.—*Behara*; Tam.—*Akkam*; Tel.—*Tandra*; Mal.—*Tusham*; M.—*Tandi*; Assam—*Hulluch*. Fruit—bitter, astrin., tonic, laxt., antipyr., used in piles, dropsy, diar., leprosy, biliousness, dyspep. and headache; when half ripe purg., when fully ripe astrin. Kernel—narcotic. Fruits contain about 17% tannin substances (I.P.C., 238; *J. Amer. Pharm. Ass.*, 1951, 475; *Chem. Abstr.*, 1951, 10497). Throughout the forests of India, below elevations of about 3,000 ft., except in the dry and arid region of Sind and Rajasthan.

T. CHEBULA Retz. S. & B.—*Haritaki*; H.—*Harir*; Bo.—*Ilirda*; Tam.—*Kadukkai*; Tel.—*Karitaki*; Mal.—*Katukka*; Assam—*Hilikha*. Fruit—astrin., laxt., alter., used externally as a local application to chr. ulcers and wounds and as a gargle in stomatitis; finely powdered used as a dentifrice and considered useful in carious teeth, bleeding and ulcerations of the gums. Bark—diur., cardi tonic. 'Tamin (*Ber. dtsch. chem. Ges.*, 1909, 353; 1919, 1238; *J. Chem. Soc.*, 1897, 1131; *J. Soc. Chem. Ind., Lond.*, 1903, No. 21); fruits contain about 30% of an astrin. substance; astringency is due to the characteristic principle chebulinic acid; also contain tannic acid (20-40%), gallic acid, resin, etc., and some purg. principle of the nature of anthra-quinone (I.P.C., 155; U.S.D., 1529). Abundant in N. India from Kangra and Kumaon to Bengal and southwards to the Deccan tablelands at 1,000-3,000 ft. and up to 6,000 ft. in Travancore; higher forests of the Bombay Ghats, Satpuras, Belgaum and Kanara.

T. TOMENTOSA W. & A. H. & P.—*Asan*; B.—*Piasal*; Bo.—*Asna*; S.—*Saradru*; Tam.—*Karupparudu*; Tel.—*Nelamadu*; Mal.—*Tempavu*; Assam—*Amari*. Decoct. of bark—astrin., taken internally for atonic diar.; applied locally to ulcers. Bark—diur., cardi tonic. Common throughout India, except in Sind and Rajasthan.

THALICTRUM (*Ranunculaceae*)

* T. FOLIOLOSUM DC.

THESPESIA (*Malvaceae*)

T. POPULNEA Soland. ex Correa. S.—*Parisha*; H. & P.—*Parasipal*; B.—*Parash*;—Bo.—*Parsipu*; Tam.—*Puvarasu*; Tel.—*Gangaravi*; Mal.—*Kallal*; Kan.—*Arasi*. Fruit, leaves and root—applied externally to scabies, psoriasis and other skin diseases. Root—tonic. Bark—astrin., given internally as an alter. Flower petals contain populnin (0.33%), populnetin (0.07%) and herbacetin (mostly as its glucd. 0.03%) (*Proc. Indian Acad. Sci.*, 1943, 17A, 26; 1946, 24A, 456; *Chem. Abstr.*, 1943, 4423; 1947, 3798). Coast forests of India, largely grown as a roadside tree in tropical regions. 24A, 456; India, largely grown as a roadside tree in tropical regions.

TINOSPORA (*Menispermaceae*)

* T. CORDIFOLIA (Willd.) Miers.

TRAGIA (*Euphorbiaceae*)

T. INVOLUCRATA Linn. S.—*Vrischikali*; H.—*Barhanta*; B.—*Bichati*; Bo.—*Kanchkuri*; Tam.—*Kamichi*; Tel.—*Dulagundi*; Mal.—*Choriyanam*; Kan.—*Turachi*. Root—diaphor., alter., given during fever when the extremities are cold; also for pains in

the legs and arms; in form of a paste used to aid the extraction of guinea-worm; in infusion given in ardent fever and in itching of the skin; forms the basis of an external application in leprosy. Fruit—rubbed over the head with a little water useful in baldness. Throughout India from the Punjab and outer Himalayan ranges eastwards to Assam, and southwards to Travancore.

TRIANTHEMA (*Ficoidaceae*)

T. PORTULACASTRUM Linn. syn. *T. monogyna* Linn. H.—*Lalsabuni*; Bo. & P.—*Bishkapra*; Tam.—*Sharunnai*; Tel.—*Galijeru*; Kan.—*Muchchugoni*; S.—*Punarnavi*; Marathi—*Pundharighentuli*. Leaves of the white variety—diur., used in oedema and dropsy due to various causes; in cases of ascites especially due to early liver, peritoneal and kidney conditions. Powdered root—bitter, cath., abortif., used in amenor. Saponin (Dymock, Warden & Hooper II, 103); alk. punarnavine up to 0.01% calculated on air-dry sample (I.P.C., 212; *Indian J. med. Res.*, 1940, 475); yields a new alk. $C_{32}H_{36}O_6N_2$ (*Quart. J. Pharm.*, 1947, 38; *Chem. Abstr.*, 1947, 7671). Throughout India.

TRIBULUS (*Zygophyllaceae*)

T. ALATUS Del. H.—*Gokhuri-kalan*; P.—*Bhakra*, *Hasak*; Bo.—*Trikundri*. Fruits—used for same purposes as of *T. terrestris*. Sind, Cutch, Desert of W. Rajasthan and Baluchistan.

T. TERRESTRIS Linn. S.—*Gokshura*; H.—*Chotagokhru*; B.—*Gokhru*; Bo.—*Lahanagokhru*; Tam.—*Nerunji*; Tel.—*Palleru*; Kan.—*Negalu*; Mal.—*Neringil*; P.—*Bhakhra*. Fruits—cooling, diur., tonic, aphrodis., used in painful micturition, calculus affections, urinary discharges and impotence; in form of infusion useful as a diur. in gout, kidney diseases and gravel. Fruits contain traces (0.001%) of an alk., a fixed oil, a small quantity of essen. oil, resins and nitrates (I.P.C., 243; *Indian J. Med. Res.*, 1929, 377; *Bull. Acad. Sci. Unit. Prov.*, 1933, 163; *Chem. Abstr.*, 1933, 4274).^{*} Throughout India and up to 11,000 ft. in Kashmir.

TRICHODESMA (*Boraginaceae*)

T. INDICUM R. Br. H.—*Chhotu kulpha*; B.—*Choto kulpa*; Bo. & Marathi—*Lahana-kalpa*; S.—*Surasa*; Tam.—*Kalhudaitumbai*; Tel.—*Guvvagutti*; Kash.—*Ratisurkha*. Plant—diur., used as an emol. poultice. Leaves—in a cold infusion considered depurative. Root—pounded and made into a paste applied to reduce swellings, particularly of the joints; pounded with water given as a drink to children in dysen. Throughout the greater part of India in the plains and Baluchistan.

TRICHOSANTHES (*Cucurbitaceae*)

T. ANGUINA Linn. S. & P.—*Chichinda*; H.—*Chachinga*; B.—*Chichinga*; Bo.—*Pandolu*; Kan.—*Padavala*; M.—*Pudel*; Tel.—*Lingapotta*. Seeds—cooling. Fruit—considered purg., anthelm. and emetic in the Philippine Islands.^{*} Extensively cultivated throughout the hotter parts of India.

T. DIOICA Roxb. S.—*Patola*; H.—*Parvar*, *Parval*; B.—*Potol*; Bo. & Gujarati—*Potala*; Tam.—*Kombupudalai*; Tel.—*Kommupotta*; Mal.—*Patolam*. Leaves—made into a decoct. with equal parts of coriander given in bilious fever as a febrige. and laxt. Root—hydragogue cath., tonic, and febrige. Fruit—used as a remedy for spermatorrhoea. Fresh juice of unripe fruit—used as a cooling and laxt. adjunct to alter. medicines. Roots contain an amorph. saponin, hentriacontane, a phytosterol a non nitrogenous bitter principle, glycosidic in nature and resembling colocynth, small amount of essen. oil, little fixed oil and traces of tannins (*Patna Univ. J.*, 1945, 56; *Chem. Abstr.*, 1947, 3174). Throughout the plains of N. India, extending to Assam and E. Bengal.

TRIGONELLA (*Leguminosae*)

T. FOENUM-GRÆCUM Linn. H., S., P., B. & Bo.—*Methi*; Tam.—*Vendayam*; Tel.—*Mentulu*; Mal.—*Ventayam*; Kan.—*Menthya*. Seeds—carmin., tonic, aphrodis.; an infusion given to small-pox patients as a cooling drink; toasted and then infused, used for dysen. Leaves—used both internally and externally for their cooling properties. Seeds contain alk. trigonelline and choline (*Ber. dtisch. chem. Ges.*, 1885, 2518; *Arch. Pharm.*,

Berl., 1887, 985; *Hoppe-Seyl. Z.*, 1932, 75; *Chem. Zbl.*, 1932, II, 1640; essen. oil (*Pharm. Ztg. Berl.*, 1903, 58); saponin (*J. Pharm. Chim., Paris*, 1919, 86; *C.R. Acad. Sci., Paris.*, 1926, 994; *Jb. wiss. Bot.*, 1937, 710; *Chem. Abstr.*, 1938, 9177); prolamin (*Biochem. J.* 1932, 1643; *Chem. Zbl.*, 1933, II, 2838); trigonelline has highly toxic action on neuromuscular preparations (*Bull. Acad. Med. Belg.*, 1939, 241; *Chem. Abstr.*, 1940, 4805); fixed and volatile oils, mucil., bitter extractive and a yellow colouring substance (U.S.D., 1635); air dried seeds contain 0.38% trigonelline and 3 mg.% nicotinic acid (*Arch. Pharm., Berl.*, 1943, 378; *Chem. Abstr.*, 1945, 5040).^{*} Punjab and Kashmir. Cultivated in many parts of India.

TRITICUM (*Gramineae*)

T. AESTIVUM Linn. syn. *T. sativum* Lam. S.—*Godhuma*; H.—*Gehun*, *Guin*; P.—*Kanak*; B.—*Gam*; Bo.—*Gahu*; Mal.—*Gendum*; Tel.—*Godumulu*; Tam.—*Godumai*. Seeds—cooling, tonic, fattening; increase appetite and relish for food; useful medicine in general disorders of health. As₂O₃, 0.03 mg. in 1 kg. grain (*Pharm. Weekbl.*, 1921, 1482; *Chem. Zbl.*, 1922, II, 113; *J. Amer. chem. Soc.*, 1919, 1212; *Biochem. Z.*, 1927, 113; *J. biol. Chem.*, 1927, 781); fresh plant oxalic acid 0.02% (*J. Amer. chem. Soc.*, 1931, 1040); grains contain Mg, Mn, Zn, Fe, Cu (*C.R. Acad. Sci., Paris*, 1932, 1527; *Chem. Zbl.*, 1932, II, 887). Widely cultivated in many parts of N. India and the Deccan Peninsula, especially in the north-west, and up to 13,000 ft. in the Himalayas and Tibet.

URARIA (*Leguminosae*)

U. LAGOPIDES DC. S.—*Prishniparni*; H.—*Pithavana*; B.—*Chakulia*; Bo.—*Dowla*; Mal.—*Orila*; Tel.—*Kolaponna*. Plant—considered alter., tonic, and anti-catarrhal; given with milk to women in the seventh month of pregnancy to produce abortion. Tropical zone, Nepal, Chota Nagpur and Bengal to Ava (Burma).

URGINEA (*Liliaceae*)

* U. INDICA Kunth.

VALERIANA (*Valerianaceae*)

* V. HARDWICKII Wall.

VANDA (*Orchidaceae*)

* V. ROXBURGHII R. Br. syn. *V. tessellata* Hook, ex G. Don.

VERNONIA (*Compositae*)

* V. ANTHELMINTICA Willd.; see CENTRATHERUM ANTHELMINTICUM (Willd.) Kuntze.

VIOLA (*Violaceae*)

V. ODORATA Linn. H. & Bo.—*Banafshah*; B.—*Banafsha*; S.—*Nilapushpa*; M.—*Vayilettu*. Plant—antipyr., diaphor., febrifuge. Flowers—emol., demulc., used in biliousness and lung troubles. Petals—made into a syrup used as a remedy for infantile disorders. Root—emetic. Roots contain glucd., methyl salicylate (*Ber. Schimmel u. Co., Lps.*, 1926, 125; 1929, 109; *J. prakt. Chem.*, 1925, 273; *Arch. Pharm., Berl.*, 1882, 378; *Amer. J. Pharm.*, 1909, 181; *Pharm. Zentralh.*, 1921, 691; 1922, 577); yields an alk. violine, a glycoside violaquercitrin which is probably identical with rutin and a saponin (*Chem. Abstr.*, 1919, 2963; U.S.D., 1645); roots contain saponin and an alk., roots, leaves and blossoms contain methyl salicylate in the form of a glucd. (*Pharmazie*, 1946, 85; *Chem. Zbl.*, 1947, 65; *Chem. Abstr.*, 1947, 6022). Kashmir, 5,000-6,000 ft., planted in many hill-stations.

VITEX (*Verbenaceae*)

V. AGNUS-CASTUS Linn. Pers.—*Panjangusht*; Arab.—*Athlak*. Seeds—bitter, boiled in ghee and the mixture given to horses for colic. Plant—used as a cure for eye diseases and stomachache; used for pains due to chills, one who has caught cold takes a bath in water in which the leaves have been boiled. Baluchistan.

*V. NEGUNDO Linn.

VITIS (*Vitaceae*)

V. VINIFERA Linn. S.—*Draksha*; H., P. & B.—*Angur*; Bo.—*Drakh*; Tel. & Kan.—*Draksha*; M.—*Trachei*; Mal.—*Gostani*; Tam.—*Kottani*. Sap of young branches—used as a remedy for skin diseases. Leaves—astrin., used in diar. Juice of unripe fruits—astrin., used in throat affections. Dried fruit—demulc., cooling, sweet, laxt., stomch., useful in thirst, heat of body, cough, hoarseness, consumption and in wasting diseases. As, 0.05 mg. in 100 c.c. fruit juice (*Arb. GesundhAmt., Berl.*, 1909, 304; *Chem. Zbl.*, 1929, II, 1085); oxalic acid in unripe fruits (*Ber. dtsh. chem. Ges.*, 1876, 982); also malic, tartaric and racemic acids (U.S.D., 1568). Cultivated in many parts of India especially in the north-west.

WRIGHTIA (*Apocynaceae*)

W. TINCTORIA R. Br. S.—*Svetakutaja*; H.—*Mitha indarjou*; B.—*Indrajau*; Bo.—*Kalakado*; Kan.—*Kirikodasige*; Mal.—*Kotakappala*; Tam.—*Vetpalai*; Tel.—*Jeddapala*. Bark and seeds—medicinal uses same as those of *Holarrhena antidysenterica*. Bark—tonic. Seeds—aphrodis. Indican (*Ber. dtsh. chem. Ges.*, 1879, 2311; *Chem. News*, 1878, 223); seeds yield 30.49% fixed oil (*J. Indian chem. Soc.*, 1946, 307). Rajasthan, Madhya Pradesh, Deccan, Konkan, S. Mahrata Country, Circars and W. Ghats of Madras State.

XANTHIUM (*Compositae*)

*X. STRUMARIUM Linn.

ZIZYPHUS (*Rhamnaceae*)

Z. SATIVA Gaertn. syn. *Z. vulgaris* Lam. Bo.—*Unnab*; H.—*Kandiari*; Kash. & P.—*Simli*. Drupes—emol., pectoral. Syrup of dried fruit—used for broncht. Leaves when chewed completely anaesthetize the taste for 5-20 minutes; yields 1.7% of amorph. or micro-crystalline substance with high potency and a gummy fraction with lower potency (*Farmatsiya*, No. 11/120, 1941, 20; *Chem. Abstr.*, 1944, 2792). Punjab, Punjab Himalayas up to 6,500 ft., eastwards to Bengal, N.W. Frontier Province and Baluchistan.

B. INORGANIC PRODUCTS

ACIDUM ARSENIOSUM (S.—*Sankhavisha*, H.—*Sankhya*) ; stomch., nerve tonic, alter., antiper., cardiac, respiratory, intestinal and sexual stim.

ACIDUM HYDROCHLORIDUM (M.—*Ooppootravagum*) ; stomch., tonic.

ADAMAS—Diamond (S.—*Heeraka*, H.—*Heera*) ; stim., tonic.

AKAKIYA—A red stone ; used as a tonic ; said to contain iron.

ALKALINE ASHES—Amongst these may be mentioned pearl ash or alkaline earth, barilla, kelp (bromine and iodine ash).

ALUMEN—Alum (S.—*Spatikari*, H.—*Phitkari*) ; astrin., caustic, hæmostatic, antisept.

ALUMEN EXSICCATUM—Burnt Alum ; astrin., caustic, checks unhealthy granulations, used in ulcers.

ALUMINII SILICAS—Felspar (H.—*Sufaid mitti*, Bo.—*Khadu*, M.—*Namon*) ; used as dusting powder.

AMMONII CHLORIDUM (S.—*Navasara*, H.—*Navasadara*) ; alter., expect., cholag., purg., useful in fever, spleen, liver, etc.

ANTIMONII SULPHIDUM—Kermes mineral (S.—*Srotonjana*, H.—*Anjan*) ; used for eye diseases.

ARGENTUM—Silver (S.—*Rajata*) ; tonic, stim., aphrodis., used for ulcers.

ARSENII DISULPHIDUM or ARSENICUM RUBRUM—Realgar (S.—*Manashila*, H.—*Lal haratal*) ; alter., febr., tonic, given in cough, asthma and skin disease.

ARSENII TRISULPHIDUM—Orpiment (S., B. & Bo.—*Haritala*) ; alter., febr., emmen.

ASBESTOS (Bo.—*Shakha palita*) ; applied to ulcers.

ASPHALTUM (S.—*Silajit*, H., B. & Bo.—*Silajita*) ; antisept., anodyne, tonic, expect., diur., used in diabetes.

AURUM—Gold (S.—*Suvarna*, H. & B.—*Sona*) ; nerve tonic, aphrodis., emmen., alter.

BARILLA : see SODA CARBONS IMPURA.

BORAX (S.—*Tunkana*, H. & Bo.—*Sohaga*) ; diur., emmen., astrin., antacid, local sedative, antisept.

CALCII CARBONAS—Chalk, Marble (H.—*Vilati-chuna*) ; used in dyspep., acidity, gout, rickets, externally desiccant, absorbent and antacid.

CALCII HYDRAS—Slaked lime ; in diar., chr. dysen., vomiting, scrofula, in washing ulcers, burns and scalds.

CALCII SULPHAS—Gypsum, Alabaster (S.—*Sanjirahat*, H.—*Sufed pathar*) ; used in fracture and on swollen parts, internally as astrin. and antacid.

CALCIUM OXIDE—Quick lime (S.—*Sudha*, *Shudhakshara*, H.—*Kali-ka-chuna*) ; antacid, in painful and gouty joints, ringworm and as depilatory, in jaundice, acidosis, urinary trouble, enlarged glands.

CARBO LIGNI—Wood charcoal (H.—*Lakrika-koyelah*) ; used in dyspep., diar., dysen., typhoid fever.

CLAY (S.—*Krishnamritrika*, H.—*Chiknimati*) ; used in dyspep., leucor., to relieve bleeding from internal organs.

CURPRI SULPHAS—Blue vitriol (S.—*Sasyaka*, *Tutta*, H.—*Nila thotha*) ; astrin., emetic, antisept., externally stim., styptic, caustic.

CUPRUM—Copper (S.—*Támra*, H.—*Támbá*) ; astrin., sedative, alter., antisept., emetic, purg., externally in piles, leprosy, skin diseases and ozæna.

FERRI SULPHAS—Green vitriol (S.—*Kasisa*, H.—*Hara-tutia*) ; hæmatinic, tonic, astrin., externally in skin diseases.

FERROSO-FERRIC OXIDE or FERRI PEROXIDUM RUBRUM—Iron rust (S.—*Manduram*, H.—*Lohaka*) ; in asthma, general debility, fever and heart disease.

FERRUM—Iron (S.—*Lauha*, H.—*Loha*) ; alter., astrin, tonic, restor.

FERRUM SULPHURATUM—Iron pyrites (S.—*Swarnamakshika*, H. & Bo.—*Sonamukhi*) ; tonic, alter., useful in anæmia, leucor., urinary diseases, ascites, anasarca, prurigo, eye diseases.

GOPICHANDAN (S.—*Shoraktri*, H.—*Panisoka*) ; used as dusting powder.

GYPNUM SELENITE—Plaster of Paris (H.—*Kulnar*) ; cooling, given as gruel in fever.

HYDRARGYRUM—Mercury (S.—*Pārada*, H.—*Pārā*) ; tonic, alter., purg., cholag., antiphyl., antisept., sialog.

JADE (H.—*Yashm*) ; liquor—drunk from a jade or agate cup is supposed to allay palpitation of heart.

KAOLINUM—China clay (B.—*Gainika*) ; for cholera, dysen., diar., septic wounds.

LAPIS LAZULI (H.—*Lajward*, Bo.—*Rajavaral*) ; astrin., refrig., externally applied to ulcers ; ultramarines.

MAGNESIA : laxt., alter., aphrodis.

MAGNESII DISILICAS—Serpentine ; used for diseases of liver.

MICA—Talc (S.—*Abhra*, H.—*Avrak*, M.—*Appracam*) ; general tonic, alter., aphrodis ; restor.

ORPIMENT : see ARSENII TRISULPHIDUM.

PHOSPHORUS : stim., powerful irrt. poison.

PLUMBI CARBONAS—White lead (H.—*Sufeda*, M.—*Velliyya*) ; locally sedative, astrin.

PLUMBI OXIDUM—Litharge (H.—*Murdosing*) ; astrin., cooling, insecticide.

PLUMBI OXIDUM RUBRUM—Red lead (S.—*Raktanag*, B. & Bo.—*Sindur*) ; used in skin diseases.

PLUMBI SULPHURATUM—Galena (S.—*Anjana*, H.—*Surma*) ; cosmetic for eyes.

PLUMBUM—Lead (S.—*Seesaka*, H.—*Sisa*) ; astrin., diur., anthelm., externally sedative.

POTASII CARBONAS (S.—*Yavakshara*, H.—*Javakhar*) ; stomch., laxt., diur., antacid., resol., alter.

POTASII NITRAS—Saltpetre (S.—*Saindhava*, H. & B.—*Sora*) ; refrig., diur.

REALGAR : see ARSENIC DISULPHIDE.

SALINE EARTHS :

JAVAKHARA—Potash carbonate impure.

NAVASAGARA—Ammonium chloride.

PAPADKHAR—Pearl ash.

SAJIKHARA—Carbonate of soda.

SHORAKHAR—Saltpetre.

TANKAN KHAR—Borax.

SALINE SUBSTANCES :

AUDBHID : in the composition of 'pancha-lavana' ; principally sulphate of soda.

GUTIKA : stomch., digest., laxt.

PANSUJA or USHASUTA : demulc., stim., stomch., laxt.

ROMAKA (H.—*Savaramith*) ; laxt., diur.

SAINDHAVA—Rocksalt.

SAMUDRA : bitter and laxt.

SAUVARCHALA (H.—*Sonchal*, *Kala-nimak*) ; stomch., digest., purg., demulc.

VIT LAVANA (S.—*Krishna lavana*, H.—*Padelon*) ; carmin., aper., tonic, stomch.

SILICATE OF ALUMINA, LIME and OXIDE OF IRON (H.—*Gill*) ; use like 'multanimati.'

- SILICATE OF ALUMINA, MAGNESIA and OXIDE OF IRON (H.—*Gherumitti*) ; refrig., astrin., absorb., antisept.
- SILICATE OF ALUMINA and OXIDE OF IRON (S.—*Gairika*, H.—*Gerumati*) ; for relieving bleeding from internal organs.
- SILICATE OF LIME (H.—*Hijrata hau*) ; cooling, demulc., externally in skin diseases.
- SILICATE OF MAGNESIA—Soap stone (H.—*Singe jerahata*) ; astrin., desiccant, styptic, internally in dysen., diar., menor., leucor.
- SILICATE OF MAGNESIA AND IRON—Serpent stone (S.—*Gorochana*, H.—*Pedaru bazara*) ; nerve tonic, astrin.
- SILICUM—Silicon ; used both internally and externally.
- SODA CARBONAS IMPURA (S.—*Sarjikakshara*, H.—*Sajjikhar*) ; antacid, alter., diur.
- SODII CHLORIDUM—Common salt (S.—*Lavana*, H.—*Nimak*) ; antisept., antiper., anthelm.
- SODII CHLORIDUM IMPURA—Rocksalt (S.—*Saindhava*, H.—*Sedhalon*) ; carmin., stomch., digest., cath., emetic.
- SODII FLUOSILICAS ; antisept., anthelm., deod., styptic., disinfectant.
- STANNUM—Tin (S.—*Vanga*, H.—*Rang*) ; in diseases of the genito-urinary organs, blood and lungs.
- STANNIC SULPHIDUM—Mosaic gold (S.—*Svarna vanga*) ; in complaints of generative organs of both male and female.
- SULPHUR (S.—*Gandhaka*, H.—*Gandak*) ; bitter, increases bile, laxt., diur., insecticide.
- ZINCUM—Zinc (S.—*Yashada*, H.—*Jasta*) ; in eye diseases, debility, urinary disorders, asthma.
- ZINCI CARBONAS—Calamine (S.—*Kharpara*, H.—*Kala khaparo*) ; nerve tonic, alter., used in syphilis, scrofula and skin diseases.
- ZINCI OXIDUM—White zinc (H.—*putty*) ; externally as a mild, soothing astrin., internally as a nerve tonic, sedative, antisp., astrin.

C. ANIMAL PRODUCTS

- ACHATINA FULICA—Land snail (Bo.—*Nakhala*) ; shell—used for preparing medicated oil.
- ACIPENSER HUSO Linn. or A. STELLATUS—A fish from which Isinglass is manufactured (H.—*Machhika-siras*, Bo.—*Aisinglasa*, M.—*Minvajaram*) ; nutri., demulc., emol., given in chr. diar. ; similar to albumen, contains pure gelatin.
- ACRIDOTHERES GINGINIANUS Lath—A bird (S.—*Atipakshi*, Saral pakhi, B.—*Gang-salik*, Ram-salik, Bo.—*Bagali-pakshina*) ; flesh—cardiac stim., beneficial in 'vitiated wind and cough.'
- ADEPS—Lard. (B.—*Charbee*) ; for ointments ; contains olein, palmitin, margarin, stearin.
- ADEPS LANAE ANHYDROSUS ; Anhydrous wool fat ; contains cholesterin.
- ADEPS LANAE HYDROSUS—Hydrous wool fat ; emol. ; contains lanolin ; cholesterin, palmitic, stearic, oleic and valerianic acids.
- AGAMA AGILIS—Sand LIZARD (Bo.—*Sarado*) ; ash—used as nerve tonic, stim., aphrodis., in spermatorrhoea.
- ALBUMEN ; emol., demulc., nutri., antid. for copper, zinc, perchloride of mercury and creosote poisoning.
- ALECTORIS GRAEA Meisner—Bartavelli (S.—*Upachakra*, B.—*Chakor*) ; flesh—astrin., generative of strength, stomch. given in high fever ; ambrein.
- AMBERGRIS—Ambergris. (S.—*Amber-sugandah*, H., B., Bo. & M.—*Amber*) ; stim., antisp.,
- ANABAS SCANDENS Daldorf. (S.—*Kabayee*, H.—*Kabai*, B.—*Kai*) ; flesh—astrin., demulc., easily digestible, cardiac stim., slight bilious and alleviative of wind.

ANIMAL FLESH :

- (a) JANGLA OR LAND ANIMALS; astrin., digest., constipating.
 (b) ANUPA OR WATER ANIMALS; demulc., fattening, soothing.
- ANTIGONE ANTIGONE Linn.—Indian Crane (S.—*Sarasa*, B.—*Saras*) ; flesh—difficult to digest. antibil., beneficial in diar. and piles.
- ANSER INDICUS Lath.—Gander or Drake (S.—*Hansa*, B.—*Hans*, Bo.—*Ballaki*) ; flesh—stim., difficult to digest, demulc., nutri., phlegm., corrective of voice and alleviative of 'vayu'; egg—stim., easily digestible, cardiac stim., aphrodis., beneficial in cough, heart disease, ulcers.
- ANTILOPE CERVICAPRA Linn.—Indian Antelope or Black Buck (S.—*Enamriga*, H.—*Farisail Harin*) ; flesh—astrin., stomch., useful in fever, ulcer, phthisis, piles, jaundice, cough.
- APIS MELLIFERA—The Honey Bee; honey—nutri., demulc., laxt.; especially for children, useful in application to ulcer.
- AQUUS ASINUS Linn.—Ass (S.—*Gardhava*, H.—*Gadha*) ; milk—stomch., cardiac stim., useful in wind and phthisis; ghee—astrin., stim., antiphlegm., easily digestible; flesh—cardiac stim.; urine—stim., stomch., useful in gout.
- AREDEOLA GRAYII Sykce—Heron (S.—*Krauncha*, B.—*Konch Bak*) ; flesh—used in fever, phthisis, cough, oedema, loss of appetite, swoon and stone in the bladder.
- ARLUS ARIUS Ham. & Buch.—Fish (S.—*Ari-matsya*, B.—*Armach*) ; flesh—difficult to digest, demulc., cardiac stim., improves memory, wind and phlegm.
- ATHENE BRAMA INDICA—Owl (S.—*Ulloka*, B.—*Pechak*) ; flesh—stim., produces 'vayu', cholag.; useful in oedema, insanity and loss of semen.
- BARBUS SOPHORE Ham. & Buch.—Fish (S.—*Proshiti*, B.—*Punti-máchh*) ; sweetish bitter, demulc., antiphlegm., alleviative of 'vayu' and beneficial in the diseases of mouth and throat.
- BEZOAR—Serpent stone. (H., B. & Bo.—*Gorochan*, M.—*Gorochana*) ; cooling, arom., prescribed in miscarriage.
- BIVALVE SHELL (S.—*Sukali*, Bo.—*Chhipa*, P.—*Sip*) ; chhipa bhasma—used in depilatory pastes.
- BOMBYS MORI—Moth. The chrysalis is the silk pod. (E.—*Pat*, Bo.—*Resham na potan*, M.—*Putloo puchie*) ; styptic, tonic, astrin., checks profuse menstruation, leucor, and chr. diar.
- BOS BUBALUS Linn.—Buffalo (S.—*Mahisha*, H.—*Bhais*, B.—*Mahish*, M.—*Dumaputu*) ; flesh—stim., demulc., difficult to digest, cardiac stim., milk—refrig., difficult to digest, demulc., cardiac stim., aphrodis., phlegm., hypnotic.
- BOS TAURUS Linn.—Cow (S.—*Go*, *Gabhi*, B.—*Goru*) ; milk—demulc., nutri., cardiac tonic, excitive of memory; ghee—stomch., nutri., antibil., tonic. improves memory; flesh—useful in fever, disease of the nose, cough, phthisis and catarrh; cow-dung—used in burns and wounds; urine—see urine.
- CALICHROUS PABDA Ham. & Buch.—Fish (S.—*Parbata*, B.—*Pabda*) ; flesh—demulc., cardiac stim., and carmin.
- CAMELUS DROMODARIUS Linn.— Camel (S.—*Ustra*, H.—*Ur*, B.—*Ut*) ; milk—easily digestible, stim., stomch., useful in piles, oedema, worms, abdominal tumours, dropsy, phthisis and leprosy; ghrita—refrig., stomch., useful in convulsion, worms, leprosy; urine—stim., bilious, cardiac stim., useful in dropsy.
- CARCHARODON CARCHARIUS Linn.—White shark; oil—subst. for cod-liver oil, richer in iodine and phosphorus than cod-liver oil but contains less bromine and sulphur.
- CASTOREUM—Dried preputial follicles of the beaver—Castor. (S.—*Gendha*, H.—*Gondbadustan*, Bo.—*Zanda bidastara*, M.—*Kasturi munai*) ; nerve stim., antisept., emmen.; contains a volatile oil, acrid bitter resin, castorin, cholesterolin and salicin.
- CATLA CATLA Ham. & Buch.—Fish (S.—*Katala*, B.—*Katla*) ; flesh—stim., difficult to digest and beneficial in disturbance of the three humours.

- CAPRA-AEGAGRUS Gmelin—Goat ; flesh—nourishing, cardiac stim., milk—sweet, cooling, astrin., beneficial in fever, bile, cough, consumption and dysen; 'chagaladya-ghrita'—specific for nervous debility.
- CEPHALOPODA : see OS SEPIE.
- SERA (S.—*Sikiha*, H.—*Mom*, Bo.—*Mum*, M.—*Mellugu*) ; emol., demulc., contain hydrocarbons, cerotic acid, myricin, ceryl alcohol.
- CERA ALBA—White Bee's wax ; local application for fistula.
- CEREVESIA LACTIS : see KUMYSS.
- CERVUS DAMA Linn.—Hart's Horn (S.—*Mrigasringa*) ; in cough, asthma, low fever, phosphaturia ; contains phosphate of lime.
- CERVUS ELEPHUS or C. EQUINUS—Stag's Horn (S.—*Samberasinga*, H.—*Barasinga*) ; local astrin., sedative, internally nerve and blood tonic ; contains calcium phosphate.
- CETACEUM—Spermaceti ; demulc., emol. ; contains acetyl alcohol combined with palmitic acid.
- CHELONIA—Turtle (H.—*Kachakru*) ; fat—used in scrofula, rickets, anaemia and pulmonary affections.
- CLAMATOR JACOBINUS Bodd. ; AEGITHINA TIPHIA Linn.—Swallow (S.—*Chataka*, H.—*Tokka*, B.—*Chatak*) ; flesh—refrig., stomch., cardiac stim., nutri., in epistaxis and phlegm.
- CLARIAS BATRACHUS Linn.—Fish (S.—*Madgura*, B.—*Magur*) ; flesh—demulc., used in diar.
- CLUPEA ILISHA Ham. & Buch. (S.—*Illisa*, H.—*Hilsa*, B.—*Ilis*) ; flesh—demulc., stomch., bilious, phlegm., carmin.
- COCCUS CACTI—Cochineal insect (H.—*Beerbough tee*, Bo.—*Kiramaja*, M.—*Cochinil puchi*) ; sedative, antisp., in neuralgia and whooping cough ; contains carmine or carminic acid, coccerin, myrestin, fat and fatty acids.
- COLUMBA DOMESTICA—Pigeon (S.—*Kapota*, H.—*Kobutar*, B.—*Payra*) ; flesh—demulc., tonic, cardiac nutri., in constip., beneficial in phlegm., bile, vitiated blood and wind, leprosy, prohibited in jaundice.
- CORALLIUM RUBRUM—Coral (S.—*Pravala*, H.—*Parvara*, Bo. & M.—*Pozale*) ; antacid, astrin., laxt., diur., nerve tonic ; contains carbonate of lime, magnesium carbonate, oxide of iron.
- CORVUS SPLENDENS-SPLENDENS Vieill.—Crow (S.—*Kāka*, B.—*Kāk*) ; flesh—stomch., nutri., cardiac stim., beneficial in ulcer, phthisis and eye disease.
- CROCODILUS POROSUS Schneid.—Crocodile (S.—*Kumbhira*, B.—*Kumir*) ; flesh—demulc., refrig. beneficial in vitiated bile.
- CROCOPUS PHOENICOPTERUS Lath.—The Green Dove (S.—*Harita*, H.—*Harial*, B.—*Hathela Ghugu*) ; flesh—astrin., refrig., easily digestible, produces 'vayu' and alleviates thirst and epistaxis.
- CYPRÆA MONETA Linn.—Shells, Cowry (S.—*Varatika*, H.—*Cowrie*, Bo. & M.—*Kavdi*) ; cowri bhasma—used in dyspep., jaundice, enlarged spleen and liver ; contains phosphate, fluoride and carbonate of calcium, magnesium phosphate, manganese.
- ELEPHAS MAXIMUS—Elephant (S.—*Hasti*, B.—*Hati*, Bo. & M.—*Aane*) ; teeth ash—astrin., in leucor., used in jaundice, conjunctivitis and sterility in women.
- EQUUS CABALLUS Linn.—Horse (S.—*Asva*) ; milk—stim., demulc. ; urine—bitter, stim., stomch., purg., beneficial in ringworm and intestinal worm.
- EUDYNAMIS SCOLOPACEUS Linn.—Cuckoo (S.—*Kokila*, H.—*Koil*, B.—*Kokil*) ; flesh—phlegm., antibil.
- FEL BOVINUM PURIFICATUM or FEL TAURI DEPURATUS—Purified Ox-Gall (S.—*Gorochanam*, H.—*Zehar-mohra*, B., Bo. & M.—*Gorochana*) ; laxt., antisp., cholag., cooling, arom., used in convulsions, hysteria.
- FEL BOVIS—Fresh Ox-Gall (H.—*Bail-ka-sofra*).
- FELIS TIGRIS Linn. ; Tiger Fat is used in leprosy, in rheum.
- FRANCOLINUS PONDICERIANUS Gmel.—Partridge (S.—*Tittiri*, B.—*Titir*, M.—*Toluk petta*) ; the flesh of the white variety is astrin., refrig., demulc., easily digestible, constipating,

cardiac stim., improves memory, beneficial in cough, phthisis, fever, epistaxis and hiccough.

GALLUS BANKIVA Zemm.—denotes wild form of the genus. The Indian domesticated gamecock is known as GALLUS PUGNEX = GALLUS PUSILLUS of Linnaeus; egg—(S. & B.—*Dimba*, H.—*Anda*, Bo.—*Bedun*, M.—*Motte*); emol., demulc., laxt., nutri., contains albumen, mucus, fat, sugar, extractive matter, lecithin.

GALLUS DOMESTICUS—Fowl; flesh—stim., demulc., cardiac stim., nutri., beneficial in disturbance of the three humours, phthisis, vomiting and remittent fever.

HALICORE DUGONG Erxleben; Dugong oil or oil of Sen Hog subst. for cod-liver oil.

HIRUDINARIA (POECILODELLA) GRANULOSA Savigny—Leech (S.—*Jaluka*, H., B. & Bo.—*Jalu*, M.—*Attei*); antiphl. anticoagulant.

IRIS NOBILIS : see CORALLIUM RUBRUM.

KING-FISHER; (B.—*Macch ranga*); flesh—refrig., demulc., useful in epistaxis, produces 'vayu'. KUMYSS or KUMISS; fermented mare's or camel's milk—dietetic, restor., given in diabetes irritability of stomach and vomiting; contains alcohol, sugar, lactic acid, salts, carbonic acid, ether.

LACCA: see COCCUS LACCA.

LACTUS—Milk (S.—*Dugdha*).

ASS'S MILK—useful in general debility, cough, chr. broncht.

BLACK COW'S MILK—good for 'vayu.'

CAMEL'S MILK—useful in dropsy, asthma, general scrofulous conditions.

ELEPHANT'S MILK—beneficial to eyes.

EWE'S MILK—useful in rheum., hacking cough.

GOAT'S MILK—useful in phthisis, chr. diar., vomiting in children.

HUMAN MILK—refrig., stomch., demulc., beneficial in eye diseases and epistaxis, recommended in chr. asthma and consumption.

MARE'S MILK—useful in rheum. of extremities.

SHEEP'S MILK—useful in obesity, flatulence and gonorr.

LEPUS RUFICAUDATUS Geoff.—Rabbit (S.—*Sasaka*, B.—*Khargosh*); flesh—refrig., astrin., stomch., cardiac stim., beneficial in fever, jaundice, diar. with fever, phthisis, cough and piles.

LOBEO ROHITA Ham. & Buch.—Fish (S.—*Rohita*, H.—*Rahu*, B.—*Rui-machh*, M.—*Eraminu*); flesh—astrin., slight stim., difficult to digest, demulc., cardiac stim., strengthening, slight bilious, beneficial in vitiated wind; bile—laxt., in bilious remittent fever.

MACACUS RHESUS—Monkey (S., H. & B.—*Banar*); flesh—difficult to digest, haematinic, beneficial in eye diseases, phthisis, cough and piles.

MEL—Honey (S.—*Madhu*, H. & Bo.—*Madha*, M.—*Taen*); demulc., laxt., nutri., contains various sugars.

MEL DEPURATUM—Clarified Honey; demulc., laxt., nutri.; contains various sugars.

MOSCHUS MOSCHIFEROUS Linn.—Musk-Deer (S., B., Bo. & M.—*Gorochanam*, H.—*Zehar-mohra*, *Kasturi*); laxt., antisp., diffusible stim., anodyne, antisp., expect., diaphor., diur., aphrodis.; contains cholesterin, fat, wax, gelatinous matter, albuminous principles.

MOTACILLA MADERASPATENSIS Gmelin—common Wagtail; (S.—*Khanjana*, B.—*Bond-na-cha*); flesh—laxt. and beneficial in diseases originated from vitiated phlegm and bile.

MUGIL PLANICEPS Cuv. & Val.—Fish (S.—*Bhokani*, B.—*Bhangan*); flesh—refrig., phlegm., difficult to digest.

MUS RATTUS—Mouse (S.—*Mushika*, H.—*Chua*, *Mush*, B.—*Indur*); flesh—demulc., cardiac stim., useful in worms and piles.

MUTELLA OCCIDENTALIS (S.—*Indravadhi*, H.—*Indragopa*); nerve tonic, antisp., used in paralysis.

- MYLABRIS CICHORII—Mylabris Beetle—(H.—*Teleni-makkhi*, M.—*Pinsttarini*) ; subst. for cantharides ; cantharidin (see page 472).
- M. PUSTULATA—Cantharides (H.—*Teleni-makkhi*) ; internally stim., diur., externally a powerful and valuable counter-irrit., vesicant (see page 472).
- OS SEPIE—Cuttle fish bone (S.—*Samudraphena*, H.—*Darya-kaf*) ; antacid, astrin., local sedative ; contains calcium carbonate, phosphate, sulphate with silica.
- OSTREA EDULIS Linn.—Oyster—The common Indian species is O. GRYPHOIDES Schl. H.—*Sipi*, B.—*Jalasukti*, *Jhinuk*, Bo.—*Kalu*) ; flesh—acrid., demulc., useful in phthisis, 'sula' and heart diseases ; ash—useful in dyspep. ; contains calcium carbonate, phosphate, sulphate, magnesium, iron oxide, alumina and silica.
- OVIS ARIES—Sheep (S.—*Mesha*, H. & Bo.—*Bhakri*, M.—*Aedu*) ; flesh—refrig., difficult to digest, excitive of bile.
- OVIS VIGNEI Bath.—Sheep (S.—*Abika*, *Mesha*, B.—*Bhera*, *Mcsh*) ; flesh—difficult to digest, excitive of bile and phlegm ; urine—stim., beneficial in leprosy, piles, 'sula', dropsy, oedema and gonorr.
- PALAEMON CURCINUS Prawn. (S.—*Chingati*, B.—*Chingri*) ; flesh—difficult to digest, constipating, cardiac stim., phlegm., beneficial in obesity, bile and vitiated blood.
- PASSER DOMESTICUS Linn.—Sparrow (S.—*Chataka*, H.—*Chaburanja*, B.—*Charai pakhi*) ; flesh—palatable, refrig., demulc., cardiac stim. and aphrodis.
- PAVO CRISTATUS Linn.—Peacock (S.—*Nilkantha*, H.—*Mur*, B.—*Maur*, Bo.—*Mor*, M.—*Mail*) ; flesh—used for contracted limbs ; grease—used medicinally.
- PEARL—see MYTILUS MARGARITIFERUS.
- PERDIX SYLVATICA—Bird (S.—*Krakara*, H.—*Kayar*, B.—*Karkati*, Bo.—*Kardhanka*) ; flesh—cardiac stim., improves memory and digestion, useful in wind, bile and in epistaxis.
- PHALACROCORAX NIGER—Diver (S.—*Valakaka*, B.—*Pankauri*) ; flesh—demulc., difficult to digest, refrig., alleviative of 'vayu'.
- PHASIANUS : see GALLUS.
- PHYSETER MACROCEPHALUS : see CATACEUM.
- PINCTADA MARGARITIFERA Linn.—Pearl (S.—*Mukta*, H. & Bo.—*Moti*, M.—*Muttu*) ; ash—stim., tonic, aphrodis., laxt., sedative, emetic, nutri., antacid.
- PISCES—Fish (S.—*Matsya*, H.—*Machchi*) ; RIVER FISH—difficult to digest, checks 'vayu', deranges 'pitta' and blood, and causes bulky stool, SHALLOW WATER FISH—deranges 'pitta,' TANK AND POND FISH—palatable and checks 'vayu' and 'pitta,' LAKE FISH—difficult to digest, FISH NEAR SPRING WATER—similar in properties to lake fish, WELL-WATER FISH—deranges 'kapha'.
- PSITTACULA KRAMERI Scop.—Parrot (S.—*Suka*, B.—*Tia*) ; flesh—easily digestible, refrig., stomach., cardiac stim., constipating, beneficial in cough and phthisis.
- RANA-TIGRINA (Frog), BUFO MELANOSTICUS (Toad) ; (S.—*Bheka*, B.—*Byang*) ; flesh—cardiac stim., phlegm., slight bilious, alleviates thirst, gonorr., phthisis, leprosy, vomiting.
- RENNET (H.—*Paneermaya*, *Pes*).
- REPTILES :
- GECKO VERTICILLATUS Laur. (S.—*Musali*, B.—*Takshakha*, H.—*Chipkuli*, M.—*Paillie*) ; used in leprosy.
- LIZARD ; flesh—tonic, stim., alter., used in syphilis ; oil—aphrodis.
- MABUIA CARINATA Schneid.—Indian Skink (P.—*Regmahi*) ; oil—stim., aphrodis., antisyp.
- PYTHON RETICULATUS Schneid. ; gall bladder—used medicinally.
- SERPENT POISON ; stim., used in collapse stage of fever and cholera.
- VARANUS BENGALENSIS Daud—Iguana (H.—*Gosamp*) ; used in consumption.
- V. SALVATOR ; cures cutaneous disorders.

RHINOCEROS UNICORNIS Linn.—The great one-horned Rhino (S.—*Khargee*, B.—*Gandar*) ; flesh—astrin., difficult to digest, nutri., cardiac stim. and alleviative of vomiting and epistaxis.

SACCOBRANCHUS FOSSILIS Bloch.—Fish (S.—*Sringi*, B.—*Singi*) ; flesh—demulc., easily digestible, cardiac stim., aphrodis., galact., in dropsy, jaundice, bile, phlegm. and wind.

SACCHARUM LACTIS : see **LACTUS**.

SCILLA SERRATA—Crab (S.—*Karkataka*, B.—*Kankra*) ; antibil., diur., laxt., hæmatinic, cardiac stim. and alleviative of 'vayu'.

SCOMBEROMORUS COMMERSIONII Lacép.—Seir Fish (H.—*Surmoyi*, M.—*Konam*) ; subst. for cod or shark oil.

SEPIA OFFICINALIS : see **OS SEPTÉ**.

SERPENT POISON (S.—*Sarpavisha*) ; see **SNAKE VENOM**, p. 474.

SNAKE (S.—*Sarpa*, B.—*Sáp*) ; flesh—stomch., beneficial in eye-disease, piles, worms.

SPONGILLA—The Sponge (H.—*Badala*, Bo.—*Vadulun*) ; astrin. ; contains gelatine, albumen and iodine.

TACCARDIA LACCA—Lac (S.—*Laksha*, B.—*Gala*, Bo. & M.—*Lakh*) ; given in hæmatemesis, caries.

TRICHOGASTER FASCIATUS Bl. Schn.—Fish (S.—*Khalis*, B.—*Khalse*) ; flesh—astrin., constipating, produces wind and alleviative of 'sula'.

TURBINELLA RAPA—Conch (S. & Bo.—*Shankha*, M.—*Sanka*) ; anodyne, carmin, digestive, astrin.

TURNIX M. TANKI Blyth. and **TURNIX DUSSUMIERI** Zemm.—Bird (S.—*Laba*, H.—*Lawa*, B.—*Baterpakhi*, M.—*Labuwapetta*) ; flesh—astrin., demulc., constipating, stomch. and beneficial in disturbance of the three humours.

UNIVALVE : see **GASTROPODA**.

URINE (S.—*Mutra*, H.—*Pesab*) ; **COW'S URINE**—laxt., diur., used in cirrhosis of the liver ; **GOAT'S URINE**—for fever, headache ; **OX'S URINE**—stomch., used in jaundice, worms, edema and diar. ; **HORSE'S URINE**—bitter, stim., stomch., purg., used in ringworm and intestinal worms ; **HUMAN URINE**—stim., stomch., cardiac stim., useful in wind, worms, skin disease.

VIVERRA ZIBETTA Linn.—Civet Cat (S.—*Gandha marjara*, H. & Bo.—*Ladana*) ; unctuous secretion—stim., aphrodis., antisp.

WHALE (S. & B.—*Timi*) ; flesh—stim., demulc., difficult to digest, constipating, induces dysep., cardiac stim., phlegm. and carmin.

XANCHUS PYRUM—Conch Shell (S.—*Sankha*, B.—*Sankh*) ; flesh—demulc., cardiac stim., nutri., phlegm., useful in phthisis, abdominal tumours.

SECTION II

A. PLANTS REPUTED TO HAVE POISONOUS PROPERTIES

Closely allied to the Indian Medicinal Plants is the large group of poisonous plants. Many of these contain powerful toxic principles which if introduced into the body of an animal in relatively small quantity will affect deleteriously and may cause serious impairment of body functions and even death. These toxic substances injure the basic life principle, the protoplasm of the cells building the animal body, the chemical constituents of which are not definitely known in all cases. The harmful effects produced by chemical substances may be immediate or accumulative, i.e., they may appear after a period of time when the poison has had time to accumulate in the body in sufficient concentration to produce its deleterious effect after repeated administration. It must be remembered at the same time that some of these poisonous principles in small doses have powerful therapeutic effects and are in fact used in the treatment of disease. Many of these plants particularly those used in the treatment of disease have been investigated and full information with regard to their active principles and their physiological action is available. In case of many others, however, very little of their therapeutic action is known. Ample opportunity for research is thus left open to the future investigators.

CRYPTOGAMS (Flowerless Plants)

Little is known about the toxicological aspects of the Cryptogams or flowerless plants of India.

(a) **Algae** : The algae which cause poisoning are mostly those which are found in stagnant waters. Normally, offensive odour may be sufficient to indicate their presence, but only microscopic examination can help in determining the identity of the algae present. Blue-green algae as a group are perhaps the most pronounced in their toxic effect. Some authorities maintain that of the organisms which produce objectionable and deleterious qualities in water, microscopic ones are the most important and that very few cases have been observed in which really serious trouble in water supplies could be attributed directly to the growth of larger plants. The question of growth of algae in water reservoirs is very important from the point of view of public health. Unfortunately, our existing knowledge with regard to the Indian algae and the deleterious effects produced by them is very meagre and investigations in this direction are urgently needed.

Certain algae, such as *Microcystis flos-aquae* (Witter.) Kirch, *Aphanizomenon flos-aquae* (Linn.) Ralfs. and species of *Anabaena*, etc. form on the surface of water what is generally called water bloom. The presence of water bloom on the surface of lakes, ponds and other open sheets of water is distasteful

to bathers and obnoxious to those living in the vicinity. Livestock compelled to drink water containing water bloom are reported to have suffered from poisoning.

Of the other possibly harmful algae, mention may be made of *Nodularia*, *Clathrocystis*, *Nostoc*, *Oscillatoria*, *Pandorina* and *Volvox* when present in large numbers.

(b) **Fungi**: Among the fungi likely to be harmful are : (i) Those which attack food and fodder plants, such as Rusts, Smuts, Ergot on rye, etc. (ii) Those found in mouldy foodstuffs or moulds. Very variable data are available as regards the poisonous effects of mouldy foodstuffs in India, but there appears to be little doubt that the presence of certain species may occasionally produce harmful effects in man and animals. Species of *Mucor*, *Aspergillus*, *Penicillium*, *Fusarium*, etc. deserve special investigation in this connection. It appears, however, that there is an appreciable difference in the susceptibility of different species of animals to the effects of mouldy foodstuffs. In general it has been stated that horses, dogs and pigs are more susceptible than ruminants and poultry, while in other animals the case may be the reverse. Very little information is available about the toxicity of moulds occurring in India and the problem requires a thorough investigation because of its great economic importance. In the meantime it would be safer to consider all fungus-infected food-stuffs as deleterious. Acute poisoning with the moulds is rarely met with and if they are taken in small quantities there is hardly any danger. Mouldy food should, however, be avoided.

(iii) **The 'Mushrooms'**: Very little information is available with regard to the Indian species of mushrooms. In spite of cases of poisoning little attention has been paid to the poisonous 'mushroom' growing in this country. There are probably many more poisonous species than have already been reported in India but on the whole their number may be smaller than is generally believed. The subject deserves the attention of mycologists in this country. A brief account of mushrooms growing in India is given hereafter.

(c) **Lichens**: Very little is known about these symbiotic organisms which consist of algal cells enveloped by the mycelium of the fungus forming a felted mass. The information available with regard to this is given below.

(d) **Other Cryptogams**: As regards the Liverworts and Mosses, little or no information is available, while the Indian representatives of Lichens, Ferns and allied plants are also largely an uninvestigated field.

Ferns: *Aspidium filix-mas*.—The male fern, is suspected to be poisonous. The roots are used in medicine and large quantities of it produce hæmorrhagic gastro-enteritis, tremor, weakness, stupor, coma, acute nephritis, and cystitis. Six drams of the oleoresin have proved fatal results in man and three ounces in the cow. This fern is not found in India, but there are several other species of *Aspidium*, which are also suspected poisonous, grow in this country. The present authors have examined Indian representatives of these plants. Some foreign species of *Osmunda*, *Davallia* and *Adiantum* are also

suspected to be poisonous and medicinally active. The information available with regard to Indian Fern is discussed hereafter.

PHANEROGAMS (Flowering Plants)

The toxicological aspects of flowering plants are better known and these may be divided into two main groups: (a) Plants poisonous to man and livestock. (b) Plants poisonous to insects and fishes.

(a) With regard to the first group, so far as the plants poisonous to man are concerned, our knowledge is fairly well advanced and many of these are used in medicine in small regulated doses. Cases of poisoning due to accident, ignorance or intention are met with but these are not common. Our knowledge regarding poisoning of livestock, however, is very meagre as compared with other countries. There are hundreds of plants connected with the food supply of 300 million or so of the bovine population of India out of a total of about 1,000 million in the whole world. The fodder supply for this livestock amounts to more than a million tons daily (excluding the concentrates). Even in its present unsatisfactory condition the cattle industry contributes roughly about 10,000 million rupees to the annual agricultural income of 20,000 million rupees of this vast country.

No figures are unfortunately available of the loss suffered through poisoning with plants in India but these must be enormous. Even in an advanced country such as the United States of America (in Montana and Colorado) it was computed that the loss inflicted on the livestock industry by plant poisoning was in the neighbourhood of 220 million dollars annually. This is a very large figure considering that the size and extent of these States as compared with India is less than one-sixth, and the fact that the knowledge with regard to the poisonous plants there is well advanced and preventive measures are in vogue. The conditions existing in India may be imagined from this.

Though the number of plants which have markedly poisonous properties is perhaps small as compared with the total species included in the Indian flora, there are many which are of common occurrence and which no doubt produce serious losses by death or illness they set up among livestock. The toxic effects produced may be accompanied by reduction in the yield of milk, or milk may become unpalatable through excretion in it of toxic substances or may even become poisonous and unfit for consumption. The animals do not instinctively select toxic plants as forage, but in some cases they do acquire a depraved appetite for harmful plants especially when the fodder supply is scarce, a condition which is of frequent occurrence in many parts of India.

Food Poisons.—Besides the plants which produce symptoms of poisoning when taken in small quantities, there are some which are commonly utilized as food and fodder, but which under certain conditions produce harmful effects. A few examples may be cited in this connection: (1) Khesari dal (*Lathyrus sativus*) is an important article of diet for man and animals. Moderate amount of this pulse can be taken with impunity but if taken in large quantities, especially

to the exclusion of other foods or fodders, it produces dangerous symptoms of poisoning in man and livestock. Examples of lathyrism in man in the form of spastic paralysis are commonly seen every day in the streets of Calcutta and its toxic effects in horses and cattle are well known. (2) Grasses form an important part of the foods of animals. Some of these develop dangerously large quantities of hydrocyanic acid under certain climatic and soil conditions, especially at times of drought or when the plants are wilting or stunted. The younger and more succulent ones are often more likely to contain lethal doses of hydrocyanic acid. If well-dried they are generally without danger. Outbreaks of poisoning due to the Indian millet (*Sorghum vulgare*) and Johnson grass (*Sorghum halepense*) are frequently recorded in India, but the problem is very imperfectly understood. (3) Linseed plant and the residual cake after the extraction of oil from the seeds have occasionally caused poisoning of livestock due to hydrocyanic acid. It is unsafe to feed the cattle on the plant especially when wilted. Cakes after extraction of the oil should be treated with boiling water and should be given only in small quantities at a time. (4) Mustard cake which is fed to the cattle after extraction of oil may produce chronic irritant poisoning, colic, lassitude, etc., if fed in large amounts and over prolonged periods. The danger seems to be less in the case of 'sarson' cake than in the case of 'rai' and the black mustard. (5) Several members of the cucumber family are edible but bitter varieties are occasionally met with. The latter are strongly purgative and should be discarded. (6) Buck-wheat under certain conditions which are not yet fully understood, becomes toxic and gives rise to inflammatory swellings of the face, eyelids and ears. These are a few examples of food poisons which are known. There are many others which need investigation.

There are a number of plants which are capable of producing irritation of the skin or even dermatitis. About 76 plants have so far been recorded in India which are capable of producing dermatitis in susceptible individuals. A number of these plants are said to have abortifacient and in smaller doses emmenagogue properties.

(b) The second group consists of plants poisonous to insects and fishes. At the present time our knowledge of plants having insecticidal and insect repellent properties in this country is meagre. A thorough enquiry into this aspect of poisonous plants is, therefore, of prime importance to the country.

It is true that quite a large number of synthetic insecticides such as DDT, Gammaxene, etc., are now available. The advantage of vegetable insecticides such as pyrethrum, derris and others is that they are comparatively less toxic to both animal and vegetable life. Besides this some of them have powerful immediate knock-down effects which are not usually met with in the synthetic insecticides. The vegetable insecticides are also more suitable for combating the plant pests and parasitic diseases because they kill them without much effect on the host plants. It is for this reason that the field for investigation of vegetable insecticides is in no way narrowed. On the other hand it has been broadened and their application is being extended at the same time in combination with

synthetic insecticides. A number of preparation of pyrethrum with DDT are in use.

There are also a number of plants that are poisonous to fishes. Very little work has been done so far in this field. Some of these piscicides are also insecticides and *vice versa* and a systematic study of this group will be fruitful. Very little systematic information is at present available about a large number of plants of this group. The economic possibilities accruing from studies of this nature are very great and their importance in medicines and veterinary practice cannot be overrated.

Plants Reputed to have Poisonous Properties

[* For detailed description refer to Parts II and III]

* ACONITUM spp.

* ACTAEA SPICATA Linn.

ADENIA (Modecca) PALMATA Engl.

A. WIGHTIANA Engl. The roots and fruits are believed to be poisonous. Deaths from fruit of A. PALMATA have been reported⁽⁶⁸⁾. Hydrocyanic acid has been reported from A. WIGHTIANA⁽⁷³⁾.

ADONIS AESTIVALIS Linn., A CHRYSOCYANTHUS F. H. & T. It is poisonous to animals and is believed to act as a poison to heart. It contains an amorphous glycoside⁽³⁶⁾.

AILANTHUS ALTISSIMA (Mill.) Swingle (A. GLANDULOSA Desf.). It is a nauseant and nervous depressant. Accumulation of its leaves in well water is reported to have produced chronic gastritis⁽⁴⁷⁾. Flowers contain essential oil⁽³⁰⁾ and bark contain a bitter substance aianthin and probably a glycoside and a saponin⁽⁷⁰⁾.

ALOCASIA INDICA Schott, A. ODORA (Roxb.) C. Koch, A. MACRORRHIZA Schott, A. MONTANA Schott. Fresh tubers are acrid and irritant.

ALLAMANDA CATHARTICA Linn. (Bo.—*Jahari sontakka*). It is a hydragogue cathartic⁽²⁰⁾.

AMMANNIA BACCIFERA Linn. (S.—*Agnigarva*, H.—*Janglimehndi*, M.—*Nirumel neruppu*).

A. SENEGALENSIS Lamk. (P.—*Paugli-mehandi*). These are acrid and vesicant when taken internally they produce severe irritation and great pain⁽⁷¹⁾.

AMORPHOPHALLUS CAMPANULATUS (Roxb.) Bl., A. LYRATUS Engl., A. SYLVATICUS (Roxb.) Kunth. (SYNANTHERIAS SYLVATICA Schott.). Fresh tubers are acrid and irritant and the seeds are intensely acrid. Seeds of A. SYLVATICUS are like Plesmonium, and fruit is intensely acrid.

ANEMONE OBTUSILOBA D. Don. (P.—*Rattan jog*). The fresh herb is vesicant and when taken internally produces vomiting and purging; drying alters its toxic properties.

* ANTIARIS TOXICARIA Lesch.

AQUILEGIA VULGARIS Linn. It is poisonous to animals.

* ARECA CATECHU Linn.

* ARGEMONE MEXICANA Linn.

* A. MARITIMA Linn.

* A. VULGARIS Linn.

* ATROPA ACUMINATA Royle.

* A. BELLADONNA Linn.

* AVENA FATUA Linn. (H.—*Kuljud*).

* A. SATIVA Linn.

BALIOSPERMUM MONTANUM Muell. Arg. (B. AXILLARA Blume). (S., H. & B.—*Danti*, Bo.—*Dantimul*, M.—*Naga-danti*). The seeds and oil are drastic purgative and the seeds in large doses are believed to be an acro-narcotic poison.

BEGONIA REX Putzeys. Its juice is poisonous to leeches⁽⁷¹⁾.

- BRASSICA CERNUA (Thumb.), Forbes *et* Hemsl., B. INTEGRIFOLIA (West) O. E. Schulz.
 B. JUNCEA (Linn.) Czern. *et* Cosson (*rai*), B. NAPUS Linn. with four varieties (*Toriva*, Sarson), B. NIGRA (Linn.) Koch (Black mustard). The seeds are vesicant; mustard cakes fed in large quantities and over prolonged periods are harmful to cattle, 'Sarson is safest cake but mixed with *rai* or black or white mustard is dangerous.'
- BRUCEA AMARISSIMA (Lour.) Merr. (syn. B. SUMATRANA Roxb.). Its seeds produce nausea, vomiting, abdominal pain and purging. From seeds an alkaloid brucamarine and a glycoside kosamine have been reported⁽⁴¹⁾.
- BUXUS SEMPERVIRENS (Linn.) (Kash.—*Chikri*, P.—*Papri*, E.—*Box-wood*). It is stated to be fatal to camels and cattle but the goats are probably immune to it. It contains alkaloids buxine, para-buxine, buxindine, buxinamine⁽⁴⁹⁾.
- * CALONYCTION MURICATUM (Linn.) G. Don (IPOMOEA MURICATA Jacq.)
 CALTHA PALUSTRIS Linn. It is acrid and poisonous; deaths among horses have been reported⁽¹²⁾. A large amount of choline is said to be present⁽³⁵⁾.
- CANAVALIA VIROSA W. & A. (C. ENSIFORMIS DC. var. VIROSA Baker). (M.—*Kattuvalamara*). Its fruit is stated to be poisonous⁽²⁷⁾.
- CAPSICUM ANNUUM Linn. (H. & P.—*Mirch*).
 C. FRUTESCENS Linn., C. MINIMUM (Roxb.). The seeds are gastro-intestinal irritant. It contains capsin, capsaicin and solanine⁽⁴⁶⁾.
- CARDIOSPERMUM HALICACABUM Linn. (S.—*Karnasphota*, H.—*Kanphuti*, M.—*Muddkottan*). Its leaves are emetic and rubefacient. The plant is said to contain saponins⁽²⁵⁾.
- CAREX CERNUA Boott. It is said to be one of the causes of 'vlei' poisoning in cattle in South Africa.
- * CASSIA ABSUS Linn.
 C. ACUTIFOLIA Delile, C. ALATA Linn., C. ANGUSTIFOLIA Vahl, C. FISTULA Linn., C. OBOVATA Collad. (Surati—*Sonamukhi*).
- * CENTELLA ASIATICA (Linn.) Urb. (HYDROCOTYLE ASIATICA Linn.).
- * CHENOPODIUM AMBROSIODES Linn., C. BOTRYS Linn.
 CHROZOPHORA ROTTLEI A. Juss. ex Spreng. (C. TINCTORIA Hook. f. in part) (H.—*Subali*, P.—*Kukronda*). It is emetic and cathartic and animals avoid it.
- CICUTA VIROSA Linn. This plant is said to have produced extensive poisoning in Europe. The active principle is cicutoxin which belongs to picrotoxin groups of poisons which are convulsant.
- * CITRULLUS COLOCYNTHIS Schrad., C. VULGARIS Schrad. ex Zectal & Zehy. (Bitter variety).
 CLEMATIS GOURIANA Roxb., C. GRAVEOLENS Lindl., C. NAPAULENSIS DC., C. ORIENTALIS Linn., C. TRILOBA Heyne, C. WIGHTIANA Wall. (S.—*Laghukarni*, H. & Bo.—*Moravela*, P.—*Oandak*). These are irritant and produce blister; these properties are altered by drying. Hydrocyanic acid has been reported in C. ORIENTALIS Linn. and C. WIGHTIANA Wall. and an active acrid principle in C. TRILOBA Heyne ex Roth⁽⁷¹⁾.
- CLEOME FELINA Linn. f., C. VISCOSA Linn. (S.—*Swarnakshira*). It acts as a vesicant.
- CLITORIA TERNATEA Linn. (S.—*Aparajita*, H. & B.—*Aparajit*, M.—*Kakkanan*). The roots are powerful cathartic like Jalap; not a safe medicine. Seeds contain a fixed oil, a bitter resinous principle and tannin⁽²⁰⁾.
- * COLCHICUM LUTEUM Baker.
 CONVULVULUS ARVENSIS Linn. (H.—*Hiranpadi*, Bo.—*Hiranpag*).
 C. SCAMMONIA Linn. The roots are strongly purgative and contain a purgative resin⁽⁷³⁾.
 CORALLOCARPUS EPIGAEUS Benth. & Hook. f. Its fruit is drastic purgative and contains a bitter principle⁽²⁰⁾.
- CORIARIA NEPALENSIS Wall. It is stated to be narcotic; the foreign species are very poisonous acting like picrotoxin and producing convulsions. The leaves contain tannin⁽²⁹⁾.
- CRINUM ASIATICUM Linn. (S.—*Visha-mandala*, H.—*Pindar*, B.—*Bara-kanur*, Bo.—*Nag-dowan*, M.—*Vishamangil*); C. LATIFOLIA Linn. (H. & Bo.—*Sukh-darsan*). Fresh roots are emetic and nauseant; diaphoretic properties are attributed to it.

CUCUMIS TRIGONUS Roxb. (S.—*Vishala*, H.—*Bislambhi*, M.—*Kattutumatti*). Root contains alkaloids narcissine, crinamine⁽²⁸⁾. The fruit is purgative and contains colocythin or a substance of similar nature⁽⁴⁵⁾.

CYNANCHUM VINCETOXICUM Pers. It is not eaten by cattle and it is regarded as poisonous. Its root is emetic and contains the glycoside vincetoxin⁽³⁷⁾.

CYPERUS LONGUS Linn. It is regarded as poisonous in South Africa.

CYTISUS SCOPARIUS Link. The plant is not eaten by cattle. It is an emetic and a cathartic. The broom tops contain the alkaloids sparteine, sarothamine and genisteine⁽⁶⁹⁾. The leaves also contain phenol scoparin⁽²²⁾.

DAPHNE CANNABINA Wall., *D. OLEOIDES* Schreih. Both are severe gastro-intestinal irritant. Camels do not eat these.

* *DATURA FASTUOSA* Linn., *D. METEL* Linn.

* *DIGITALIS PURPUREA* Linn.,

DIOSCOREA BULBIFERA Linn., *D. HISPIDA* Dennst. (*D. DAEMONA* Roxb.), *D. PRAZERI* Prain & Burk. (*D. DELTOIDEA* Wall.). These tubers are all very acrid but in most cases boiling makes them edible. Tubers contain toxic principle dioscorine^(32, 54).

DROSERA PELTATA Sm. var. *LUNATA* Clarke. (H.—*Mukhajali*, P.—*Chitra*). The plant is used as antisyp., alter., and tonic. Leaves contain proteolytic enzyme of the pepsin type⁽⁷³⁾. *D. SPATHULATA* Labill. (*D. BURMANNI* Vahl.). It is rubefacient. Some Australian species are reported to be injurious to sheep. The plant contains naphthaquinone⁽³⁾.

ELAEODENDRON GLAUCUM Pers. (H.—*Bakra*, Bo.—*Bhuta-pala*, M.—*Selppa*). It is emetic; overdoses produce fatal results⁽³³⁾.

ERVATAMIA DICHOTOMA (Roxb.) Blatter (*TABERNAEMONTANA DICHOTOMA* Roxb.). The seeds are powerfully narcotic and poisonous⁽⁷¹⁾.

* *ERYTHROXYLUM COCA* Lam.

FIGUS sp. Some species contain an acrid juice; according to Watt fruit of *F. BENGALENSIS* is poisonous to horses⁽⁷¹⁾.

FLEURYA INTERRUPTA Gaud.

GARCINIA MORELLA Desr. It yields a gum resin which is a violent gastro-intestinal irritant⁽⁴²⁾.

GNAPHALIUM LUTEO-ALBUM Linn. (P. & B.—*Blraksha*). It is suspected of causing live-stock-poisoning in South Africa⁽⁶⁶⁾.

HALOXYLON RECURVUM Bunge ex Boiss.; *H. SALICORNICUM* Bunge ex Boiss. Both these are stated to be poisonous but *H. RECURVUM* is a favourite food of camels.

HELIOTROPIMUM EICHWALDI Steud. (H. & P.—*Nilkattei*, Kash.—*Chirghas*). *H. INDICUM* Linn. (S.—*Hastisunda*, H. & B.—*Hatisura*, Bo.—*Burundi*, M. & Tel.—*Kodukki*). These are suspected to be poisonous. Stated to contain an alkaloid⁽²⁰⁾.

* *HOLARRHENA ANTIDYSENTERICA* Wall.

HOMALOMENA RUBESCENS Kunth. It is stated to be poisonous.

HURA CREPITANS Linn. Its seeds and oil are violent purgative; milky juice is very irritant. It contains a toxic substance and an alkaloid⁽⁴⁸⁾.

* *HYOSCYAMUS MUTICUS* Linn., *H. NIGER* Linn. (S.—*Parasikaya*).

HYPERICUM PERFORATUM Linn. (H. & P.—*Bassant*). It is poisonous to animals, especially horses, if taken in excess; usually it is not eaten⁽⁶⁶⁾. It contains tannins and an essential oil consisting of olefinic terpenes, pinene and sesquiterpenes⁽⁶⁷⁾.

ILICCIUM GRIFFITHII Hk. f. & T., *I. RELIGIOSUM* Sieb. & Zucc. (H.—*Anasphal*, Bo.—*Badian*, M.—*Anashuppu*). This is the star anise of China (*I. VERUM* Hook. f.) which was imported into India sometimes adulterated with *I. RELIGIOSUM*. The latter is

believed to be a respiratory and cardiac poison. Indian *I. GRIFFITHII* also is referred to as poisonous. *I. GRIFFITHII* contains bitter principle and *I. RELIGIOSUM* an essential oil⁽³¹⁾.

INULA GRAVEOLENS Desf. It is suspected to be poisonous to livestock and contains a yellowish green volatile oil⁽⁴⁴⁾. Preparations from this plant are reported to be capable of paralysing both respiration and motor activities in animals⁽⁴³⁾.

IPOMOEA REPTANS (Linn.) Poir. (*I. AQUATICA* Forsk.) (S.—*Kalambi*, B.—*Kalmisak*, Bo.—*Nalichi baji*, M.—*Sarkarei-valli*). *I. PURGA* Heyne. *I. NIL* Roth (*I. HEDERACEA* Jacq.). These are strongly purgative and irritant poisons in overdoses. The seeds of *I. HEDERACEA* Jacq. contain a resin from which a resin glycoside, pharbitin has been isolated^(35' 4' 3).

JUNCUS EFFUSUS Linn. It is suspected to be poisonous to livestock in South Africa. This and other species in India are worth investigating.

LACTUCA TATARICA C.A. Meyer var. *TIBETICA* C.B. Clarke. It is occasionally browsed by sheep; sometimes injurious⁽⁶⁴⁾.

LAGENARIA VULGARIS Seringe (Wild variety). It acts as a drastic purgative and its seeds contain saponins⁽⁷³⁾.

LAGERSTROEMIA INDICA Linn., *L. SPECIOSA* (Linn.) Pers. (*L. FLOS-REGINAE* Retz.) (S.—*Arjuna*, H. & B.—*Jarul*, Bo.—*Taman*, M.—*Kodali*). The bark and leaves are purgative; seeds of the first named species have narcotic properties.

LAMIUM AMPLEXICAULE Linn. It is regarded as injurious in America.

LANTANA ACULEATA Linn. (*L. CAMARA* Linn.) (Bo.—*Ghaneri*, M.—*Arippu*). The reports about its being poisonous to livestock have been received from the Punjab and Assam Government Departments. It contains an essential oil⁽⁷⁾.

LATHYRUS APHACA Linn., *L. SATIVUS* Linn. (S.—*Triputi*, H. & B.—*Khesari*, Bo.—*Lakh.*). It is a food and fodder. *L. SATIVUS* if taken in larger amounts and over prolonged period produces lathyrism in man and animals.

LINUM USITATISSIMUM Linn. (S.—*Atasi*, H. & B.—*Tisi*, Bo.—*Alasi*, M.—*Alshiviral*). The young plants are known to produce death in animals; sometimes seed cake also harmful. The seeds contain a cyanogenetic glycoside and phaseolunatin⁽⁷³⁾.

LOBELIA EXCELSA Lesch., *L. NICOTIANAEFOLIA* Heyne. Both are acrid poisons. *L. NICOTIANAEFOLIA* contains alkaloid lobeline⁽¹⁷⁾.

LOCHNERA PUSILLA K. Schum. (*VINCA PUSILLA* Murr.), *L. ROSEA* (Linn.) Reichb. (*VINCA ROSEA* (Linn.)). It is a cardiac poison and *L. PUSILLA* is regarded as poisonous to cattle. They contain an amorphous alkaloid vincarosline⁽⁸⁾.

LOLIUM PERENNE Linn., *L. TEMULENTUM* Linn. (H.—*Machni*). Several cases of poisoning, mostly non-fatal in man and animals, from eating the seeds of *L. TEMULENTUM* have been recorded. Gastro-intestinal irritation and severe nervous symptoms are reported.

LUFA ACUTANGULA Roxb. var. *AMARA* Clarke. (S.—*Koshataki*, H. & Bo.—*Torai*, B.—*Jhinga*, M.—*Pikunkai*). *L. AEGYPTIACA* Mill. ex Hook. f. (S.—*Rajkoshataki*, H.—*Chiatarui*, B.—*Dhundul*, Bo.—*Ghosali*, M.—*Cattibira*). Wild variety. *L. ECHINATA* Roxb. (S.—*Koshataki*, H.—*Kukarlata*, B.—*Ghosallata*, Bo.—*Kukarwele*, M.—*Panibira*). The fruit of *L. ACUTANGULA* var. *AMARA* (is violently emetic and purgative and is not eaten. Others are also purgative. The fruit of *L. ACUTANGULA* var. *AMARA* contain an amorphous bitter substance and the seeds contain a purgative oil⁽⁷⁸⁾. *L. ECHINATA* contains a bitter substance luffein⁽²⁰⁾.

LYCIUM BARBARUM Linn. (Vern.—*Baluchi-koh-tor*). It is reported to be poisonous to livestock. Young leaves contain HCN⁽⁵⁷⁾.

MALVA PARVIFLORA Linn. (H.—*Panirak*). It is reported to have produced narcotic poisoning in animals^(12' 13).

MANDRAGORA CAULESCENS Clarke. It is suspected to be poisonous. It contains an alkaloid mandra-gorine⁽⁵⁰⁾.

MANIHOT UTILISSIMA Pohl. (Baz.—*Cassarva*, M.—*Maravuli*). Its fresh tubers are extremely poisonous and cassava or tapioca meal is specially prepared. It contains cyanogenetic glycoside⁽¹⁹⁾.

MECONOPSIS ACULEATA Royle (Simla—*Kanta*), M. NAPAULENSIS DC. The roots are considered to have narcotic properties.

MELILOTUS ALBA Desr. It is stated to be poisonous to cattle⁽⁷¹⁾.

MYRISTICA FRAGRANS Houtt., M. MALABARICA Lam. (Bo.—*Jaiphal*) possibly some others also. These have narcotic properties and occasional cases of poisoning are reported. It contains an essential oil and a saponin⁽¹⁶⁾.

NARCISSUS TAZETTA Linn. (P.—*Nargis*). Its bulbous roots are emetic and purgative, produce irritant poisoning in over doses. Roots contain the alkaloid tazeltine⁽⁶⁾.

* OPERCULINA TURPETHUM (Linn.) Mens. (IPOMOEA TURPETHUM R.Br.).

PANICUM MAXIMUM Jacq. It is suspected to be responsible for the production of 'Dikoo' a disease affecting young sheep in Africa.

PAPAVER DUBIUM Linn., P. NUDICAULE Linn., P. RHOEAS Linn. (S.—*Rakta-posta*, H.—*Lalpost*, Bo.—*Janglimudrika*; M.—*Shivappupostaka chedi*), P. SOMNIFERUM Linn. (S.—*Ahiphene*, H. & B.—*Afm*, Bo.—*Aphu*, M.—*Postakatol*). All species yield opium more or less but *P. somniferum* is the chief source. Opium is a poison used for suicidal purposes.

PASPALUM SCROBICULATUM Linn. (S.—*Kodrava*, H.—*Kodo*, B.—*Kododa-dhan*, Bo.—*Kodra*, M.—*Kiraruga*). The 'Kodra' poisoning is very similar to LOLIUM TEMULENTUM poisoning; the animals suffer much more than men. The animals should be prevented from grazing on the crop.

* PHYSOCHLAINA PRAEALTA Miérs. (P.—*Nandru*).

PHYTOLACCA LATBENIA (Buch-Ham.) H. Walt. (P. ACINOSA Hook. f., B. I. non Roxb.). (H.—*Matazor*). It is stated to be poisonous if eaten raw, but it is edible when cooked. A toxic substance is reported to occur in the root⁽⁴⁴⁾.

PIPER sp. Harmful effects of P. BETLE Linn. and P. NIGRUM Linn. are well known. Essential oil, chavicol and enzymes are reported from P. BETLE⁽²¹⁾.

PLESMONIUM MARGARITIFERUM Schott. Its crushed seeds produce local anaesthesia and it is used as a cure for toothache.

POLYGALA CHINENSIS Linn. (H.—*Meradu*, Bo.—*Negli*), P. CROTALARIOIDES Buch.-Ham. (Santh.—*Lil kathi*). P. TELEPHIOIDES Willd. It has an acrid taste and is an emetic. The roots contain haemolytic saponins, senegon and senegin⁽³⁴⁾.

PRUNUS AMYGDALUS Batsch. (bitter variety) (H., B. & Bo.—*Badam*, M.—*Vadam-kottai*), P. ARMENIACA Linn. (H.—*Khubani*, P.—*Gurdlu*), P. AVIUM Linn., P. CERASUS Linn., P. MAHALEB Linn. (S.—*Priyangu*), P. PADUS Linn. (H.—*Hamana*, P.—*Jamma*), P. PERSICA Stokes (H.—*Aru*), P. PUDDUM Roxb. (S.—*Padmaka*, H.—*Paddam*, Bo.—*Padma-kasta*), P. UNDULATA Buch.-Ham. The seeds are poisonous and the leaves of many species are said to be dangerous to livestock when wilted; harmless when on the plant, suspicious when dried, the seeds contain glycoside amygdalin which on hydrolysis yields hydrocyanic acid^(50' 73' 15' 60' 74' 23).

* PSYCHOTRIA IPECACUANHA Stokes.

PYRUS AUCUPARIA Linn., P. MALUS Linn. The bark of P. AUCUPARIA is irritant to the alimentary tract and wilting leaves of other species are occasionally poisonous to animals browsing upon them.

RUMEX ACETOSA Linn., R. ACETOSELLA Linn. (S.—*Chutrika*, B.—*Chukapalam*). Oxalic acid poisoning is produced if eaten in excess.

SALSOLA KALI Linn. It is suspected to be poisonous but a feeding test with half dried plants in flowering stage was negative. Oxalic acid reported from it⁽¹⁾.

SAMBUCUS EBULUS Linn. (P.—*Mushkiara*), **S. NIGRA** Linn. Both are strongly purgative, **S. EBULUS** has foetid smell when bruised and is not eaten by cattle; poisoning amongst boys and fowls reported. Leaves and unripe berries contain cynogenetic glycoside^(28' 10' 11' 61).

SAPONARIA VACCARIA Linn. (H.—*Musna*, B.—*Sabuni*) and probably some others of the family. It is acrid and its toxicity is partially removed by boiling⁽⁴⁷⁾.

SAUROMATUM GUTTATUM Schott. Tubers are regarded as very poisonous.

* **SCIRPUS CORYMBOSUS** Heyne.

* **SCILLA INDICA** Baker.

SCOPOLIA ANOMALA (Link. et Otto) Airy Shaw. (**S. LURIDA** Dunal). It is poisonous and its action is like that of atropa.

SECAMONE EMETICA R.Br. (B.—*Shada-buri*). The roots are acrid and the plant is powerfully emetic.⁽³⁵⁾

SENECIO spp. (**S. VULGARIS** Linn. introduced plant). It is an important genus worth study in India; ragwort poisoning due to several species is well known in animals in foreign countries; various species produce hepatic cirrhosis.

SIDA RHOMBIFOLIA Linn. (S.—*Atibala*, H. & B.—*Swet barela*, M.—*Athiball oetus*). The ripe capsules are reported to be fatal to fowls⁽⁴⁷⁾.

SINAPSIS ALBA Linn. (white mustard). It resembles **BRASSICA NIGRA** in its properties.

SOLANUM DULCAMARA Linn. (S.—*Kakmachi*, P.—*Ruba-barik*). **S. INCANUM** Linn. (**S. CONGULANS** Forsk), **S. NIGRUM** Linn. (unripe berries). (S. & B.—*Kakamachi*, H.—*Makoi*, Bo.—*Mako*, M.—*Manattak kali*), **S. SPIRALE** Roxb. (H.—*Mungas kajur*, *Bagua*). **S. TUBEROSUM** Linn. (Sprouting). Cases of poisoning among human beings and animals are reported, some of them fatal. These are gastro-intestinal irritants occasionally associated with atropa-like symptoms. Alkaloids solanine and solanidine in **S. DULCAMARA** and solanine in **S. NIGRUM** are reported⁽⁵²⁾.

SORGHUM HALEPENSE (Linn.) Pers. (H.—*Baru*, B.—*Kala-mucha*). **S. SACCHARATUM** Pers. (H. & Bo.—*Deo-dhan*, M.—*Tella-Jonna*). **S. VULGARE** Pers. (S.—*Jananala*, H. & B. & Bo.—*Jowar*, M.—*Cholam*). These are good fodder plants but occasional poisoning is reported with stunted growth under drought condition. The frosted leaves, or second growth is dangerous. HCN reported from these^(18' 63).

STEUDNERA VIROSA (Kunth) Prain. (**COLOCASIA VIROSA** Kunth). It is believed to be poisonous.

STIPA SIBIRICA Lamk. It is believed to be poisonous to horses and mules. Said to contain a cyanogenetic glycoside. Mechanical action of 'seeds' should not be overlooked.

SUAEDA FRUTICOSA Forsk. It is stated to be poisonous.

TACCA PINNATIFIDA Forst. (Bo.—*Divu*, M.—*Karachunai*). The tuber is intensely bitter, acrid and poisonous when fresh; yields nutritious starch by maceration and repeated washing.

TERMINALIA BOLERICA Roxb. (S.—*Bahira*, H. & B.—*Bahera*, Bo.—*Behara*, M.—*Akkam*), **T. CHEBULA** Retz. (S. & B.—*Haritaki*, H.—*Harir*, Bo.—*Hirida*, M.—*Kadukkay-pu*). **T. BOLERICA** is reported to be a fish poison. The kernel is stated to be poisonous and cases are reported where narcotism occurred followed by nausea and vomiting. The evidence however, is conflicting. Some varieties of **T. CHEBULA** are drastic purgative⁽²⁰⁾.

* **THEA SINENSIS** Linn.

THOMSONIA NEPALENSIS Wall. It is acrid when fresh.

TRAGIA BICOLOR Miq., **T. INVOLUCRATA** Linn. (with varieties). (S.—*Vrischikali*, H.—*Barhanta*, B.—*Bichuti*, Bo.—*Kanchkuri*, M.—*Kanchuri-vayr*). These are stinging nettles.

TRIANTHEMA PENTANDRA Linn. (P. & Bo.—*Bishkapra*). **T. PORTULACASTRUM** Linn.

- (*T. MONOGYNA* Linn.). The roots are irritant and cathartic. The leaves and stems are used as pot herb ; occasionally said to produce paralysis and diarrhoea (⁶⁴ 20' 5).
- TRIBULUS TERRESTRIS* Linn. The plant contains an alkaloid, resin, a fixed oil and an essential oil(¹⁴). It produces the disease "Geeldi"(⁷²).
- TRICHOSANTHES BRACTEATA* Voigt. (*T. PALMATA* Roxb.). (S.—*Mahakala*, H.—*Lal indrayan*, B.—*Makal*, Bo.—*Kaundal*, M.—*Korattai*). *T. CUCUMERINA* Linn. (H.—*Jangli-chichonda*, S.—*Patola*, B.—*Bonpatol*, Bo.—*Ranparul*, M.—*Pudol*), *T. DIOICA* Roxb. (S.—*Patola*, H.—*Parvar*, B.—*Potal*, Bo.—*Potala*, M.—*Kombu-pudalai*). The roots are powerful cathartic. Fruit of *T. CUCUMERINA* is never eaten, because of its powerful cathartic action. Fruit of *T. BRACTEATA* is used as cattle poison(⁷⁵) and to destroy crows(⁷¹) *T. BRACTEATA* contains a bitter substance(²⁰).
- TRIFOLIUM REPENS* Linn. It is highly prized fodder in Europe. It is very suspicious in the Himalayas where poisoning has been reported in horses. Fresh plant contains a cyanogenetic glycoside.(⁵⁶).
- TRITICUM AESTIVUM* Linn. (S.—*Godhuma*, H.—*Gehum*, Bo.—*Gahu*, M.—*Godumula*). Under certain conditions it becomes deleterious as a fodder.
- TYLOPHORA FASCICULATA* Buch. (Bo.—*Bhuidari*), *T. INDICA* (Burm. f.) Merr. (*T. ASTHMATICA* Wight and Arn.). Leaves are emetic, diaphoretic and expectorant. *T. FASCICULATA* is used as rat poison. Fatal cases are reported in man and it contains an alkaloid(²⁰). *T. INDICA* contains two alkaloids typhorine and tylophorinine(⁵⁵ 70).
- TYPHONIUM TRILOBATUM* (Linn.) Schott. (B.—*Ghet-kochu*, M.—*Karunaik kishangu*).
- URGINEA COROMANDELIANA* Hook. f., *U. INDICA* Kunth. The bulbs are irritant poison. The foreign species *U. SCILLA* is a fish poison. The Indian species have the same action.
- VERBENA OFFICINALIS* Linn. (P.—*Pamukh*). Entire plant contains a glycoside verbenalin(⁹).
- VICIA SATIVA* Linn. (H.—*Ankra*, B.—*Ankari*). The seeds have been reported to cause lathyrism and contain cyanogenetic glycoside vicianin(¹³).
- VISCUM ALBUM* Linn. and possibly others. The poisonous properties are probably acquired if growing on poisonous hosts, e.g. *STRYCHNOS NUX-VOMICA*.
- **XANTHIUM STRUMARIUM* Linn.
- ZANONIA INDICA* Linn. (S.—*Dirghapattra*, H.—*Chirpoti*). The fruit is said to be acrid cathartic; in indigenous medicine it is believed to possess purgative and antiseptic properties.

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B. PLANTS LIABLE TO PRODUCE DERMATITIS

There are a number of plants which are capable of producing irritation of the skin. This may be brought about by contact with the skin as in the case of some species belonging to the genera *Rhus*, *Holigarna*, *Urtica*, etc. resulting in minor or temporary irritation and inflammation with vesicles or blisters, depending on the severity of the contact and the susceptibility of the individual. Further, there are certain plants, such as *Fagopyrum esculentum* Moench, *Hypericum perforatum* Linn. etc. which if ingested by certain livestock under certain conditions lead to a photosensitization and consequent dermatitis of the unpigmented portions of the skin. Dermatitis may, therefore, be either produced by contact with irritant substances produced by the plant or by ingestion of the plant itself. An important point to remember in the case of these plants is that a number of them produce dermatitis only occasionally in individuals who are especially susceptible to them. Others are more troublesome and cause dermatitis in many, but not all, individuals who may come in contact with them or ingest them. The spines and thorns of a number of plants are also capable of entering the skin and setting up irritation. In some cases when the punctures so formed in the skin become subsequently infected with harmful micro-organisms serious septic wounds may be produced. Such plants are found in abundance in India, but obviously the injury they inflict is mechanical. On the other hand, the hair on the pods of some species of *Mucuna* have more or less a mechanical action in producing irritation; unlike the sharp spines which produce merely mechanical injury they produce prolonged irritation and itching due possibly to the presence of certain chemical substances. It has been considered desirable, therefore, to draw attention

to the existence of such plants, the irritation produced by which very closely resembles that produced by stinging nettles.

In India approximately 76 plants occur which are capable of producing dermatitis in susceptible individuals. In some cases their action is explicable by the presence of irritant substances produced by the plants, in other cases the phenomenon is not yet fully understood. The following are some of the important types of plants which may injure the skin and which are usually met with in this country:

(1) RHUS TYPE WHERE THE JUICE OF PLANT COMES IN CONTACT WITH THE SKIN AND PRODUCES DERMATITIS: Sollmann¹ writing about some of the foreign species of *Rhus* says "Contact with certain species of *Rhus* common along roadsides, on fences, in woods and swamps, etc., produces typical dermatitis passing through the successive stages of hyperemia and itching, to violent vesication, edema, and suppuration, according to the specific sensibility of the individual; many persons are practically immune, although a sufficient quantity of the isolated toxicodendrol has never failed to produce dermatitis. The active ingredient of all the species is a phenolic oily resin, toxicodendrol, contained in the sticky sap of the plants, which exudes when the plant is injured. It is identical or very similar in all the toxic *Rhus* species. It is so highly active that 1/1,000 mg. has caused severe vesication. Toxicodendrol is not volatile, but it may be conveyed to some distance in the soot, in the smoke of burning plants, and perhaps on dust, and by insects alighting on injured plants. None present in the pollen, as has been claimed. It may be conveyed by the hands or clothing from one person to another, as if it were contagious."

Travellers in the Himalayan forests often hear some of the villagers having almost similar belief regarding the Indian species of *Rhus*. They would not touch the *Rhus* trees or have anything to do with them; some of them actually avoid even, passing under them. Even the smoke, smell or sight, they say, will cause swelling and vesication of the skin. And yet it has been observed that many individuals are immune to these plants. To a lesser extent species of *Holigarna* are similarly dreaded in India. Such cases of poisoning may be treated in the following manners: After contact the exposed part may be freely washed with some alkaline solution. A 5 per cent. solution of ferric chloride or ordinary soap solution are best used for the purpose. Before exposure, use of this measure may prevent the manifestation of harmful effects. Local application of baking soda or Epsom salts one or two teaspoonful to a cup of water, or a 5 per cent. solution of potassium permanganate may relieve the pain caused by inflammation. Fluid extracts of *Grindelia*, diluted with 6 to 10 parts of water is recommended for preventing the spread of inflammation. Ointments containing fatty or oily substances should not be used as the poison is soluble in oils and will, therefore, spread over other parts. Such emollients may, however, be applied as soothing agents, after the poison has been thoroughly washed away. It has been found by experiments that a certain amount of tolerance to the toxic effects of this plant may be developed in man by giving it by the mouth in small and increasing

doses of an alcoholic extract made from the plant to susceptible individual. Attacks of dermatitis in man caused by these plants may be prevented by subcutaneous injection of the alcoholic extract. The immunity produced by this method, however, does not persist longer than one month (Schamberg²).

Important families which include plants whose juices are harmful are Anacardiaceae, Asclepiadaceae, Araceae and Euphorbiaceae. Species of *Semecarpus*, *Rhus*, *Holigarna*, *Excoccaria*, *Euphorbia*, *Calotropis*, *Arisaema*, etc. are the wellknown examples in such plants.

(2) URTICA TYPE WHERE APPARENTLY THE STIFF HAIRS ON THE PLANT ARE RESPONSIBLE FOR PRODUCING DERMATITIS: Urticaria produced by contact with the hairs on the stinging nettle, such as species of *Urtica*, *Girardinia*, *Laportea*, *Fleurya*, *Tragia*, etc. is well-known. This urticaria is an inflammatory disorder accompanied by a considerable burning and itching in the affected part. The rash may come out in large or small patches, remaining for a few minutes or several hours and may disappear quite abruptly. It usually leaves no trace behind. *Laportea crenulata* Gaud. is perhaps the worst of all stinging nettles found in India. Contact with its hairs produces severe burning pain which may last for several days and is said to be greatly aggravated by the application of water. The sting is particularly powerful during the flowering season when it is said to bring on violent sneezing, sleeplessness and fever, hence the local English names Fever nettle, Devil nettle, by which the plant is known to coffee planters. According to Haines³ the plant is quite innocuous at some times of the year. This may be so on account of the hairs being deciduous, and that they are especially abundant on the inflorescence, but we have never found the plant to be entirely harmless at any time. Haines remarks that while cutting coupe-lines in November in the Sikkim Terai, where it is sometimes gregarious, his coolies were attacked with sneezing, violent catarrh and ultimately vertigo, apparently from inhaling the numerous minute hairs. Out of all these stinging nettles the mechanism of producing dermatitis in the case of *Urtica dioica* Linn. is well understood and it is likely that others may resemble this plant to a greater or less degree. What happens in the case of *Urtica dioica* is that the very fragile ends of the hair penetrate the skin and are broken off. The irritating principle from inside the hair is brought in contact with the tissues and the uncomfortable itchy sensation accompanied by nettle rash supervenes. It has generally been accepted that the irritating material in the stinging hairs of this plant is formic acid, but investigation by Cleery⁴ has thrown a considerable light on the subject. According to this author the protoplasm of these hairs has an alkaline reaction, and encloses an acid cell sap. The cell sap contains a small amount of formic acid as well as acetic, butyric and other volatile fatty acids. The specific poison of the cells, which is a non-volatile substance of an acid nature allied to the resin acids, is in solution in these acids. It is neither formic acid, nor probably an enzyme, or a toxalbumin. According to Cleery⁴ it is without doubt allied to the irritant substances found in some Primulaceae, Anacardiaceae and allied plants. A popular remedy against the stings of these stinging nettles is to rub over the

affected part the leaves of *Rumex nepalensis* Spreng. and *R. orientalis* Bernh. which are commonly met with and are often found near the nettles. They afford substantial relief; but if these are not available one's own saliva rubbed in, is quite effective. Dilute ammonia is a good remedy and if available should be rubbed in over the affected parts.

(3) PHOTSENSITIZATION CAUSED BY THE INGESTION OF PLANTS: Some plants, such as *Fagopyrum esculentum* Moench and *Hypericum perforatum* Linn., if ingested under certain conditions and stages of growth are capable of producing photosensitization and consequent dermatitis of unpigmented portions of the skin. All kinds of stock and laboratory animals which have an unpigmented skin and which are exposed to sunlight after the ingestion of the plant are liable to get this condition. Animals having pigmented skins or those not exposed to bright sunlight do not develop any symptoms. Photosensitization can be prevented by (a) feeding these plants to stabled animals only and discontinuing the feeding about a month before animals are sent out to graze; (b) allowing such animals to graze in the early morning, late afternoon and at night only; and (c) by covering or staining albinos and white parts of pigmented animals. When the animal is actually affected, feeding must be discontinued at once. The animal must be immediately shaded and a purgative given. Symptomatic treatment should also be applied. Among human beings, certain individuals are known to be sensitive to buckwheat which comes under this category. Severe itching is experienced and a rash is produced after eating food made from buckwheat flour.

(4) MISCELLANEOUS: Some plants, such as *Xanthium strumarium* Linn., produce dermatitis only in very few individuals who are sensitive to this plant and that too only at the prefruiting stage. This has been observed in the case of plant collectors who have often suffered by contact with this plant. The poisonous principle responsible for this action is not known. In other cases, such as in *Lasiosiphon eriocephalus* Decne., contact with the plant under natural conditions does not usually produce dermatitis. The dust from dried plants produces smarting of the eyes and mucous membranes and even of the intact skin. Essential oils contained in the plants are sometimes responsible for irritating the skin, such as in the case of *Erigeron canadensis* Linn. and *Ruta graveolens* Linn. The resin from the root-stocks of *Podophyllum hexandrum* Royle is capable of producing severe irritation of the eyes and the mucous membranes generally. There are in addition a number of plants the exact mechanism of whose action or the active principles responsible for producing dermatitis are not yet fully understood. Research could be profitably undertaken on these plants so that rational treatments may be evolved against their injurious effects.

Below is given a list of plants occurring in India, which have been responsible for producing dermatitis. Their English names, common vernacular names, distribution, part or parts responsible for this condition and their chemical constituents and other general information, so far as these are known, are indicated for each species.

Plants Liable to Produce Dermatitis

[* For detailed description refer to Parts II and III]

* *ABROMA AUGUSTA*, Linn.

AILANTHUS ALTISSIMA (Mill.) Swingle syn. *A. GLANDULOSA* Desf. English—*Ailanto*; Chinese—*Sumach*; Japan—*Varnish tree*, *Stinking cedar*, *Tree of the Gods*, *Tree of heaven*. It is a large deciduous tree met with in the hills of northern India, most probably introduced from Japan. The flowers contain essential oil (Isaev⁵). The bark contains 0.005 per cent. of a very bitter crystalline substance named ailanthin and probably also a glycoside and a saponin (Wasicky and Orien⁶). The leaves and flowers cause dermatitis.

ANACARDIUM OCCIDENTALE Linn. English—*Cashew nut*, *Cashew apple*; (H. & Bo.—*Kaju*; B.—*Hijli badam*). It is a small tree originally introduced from South America; now established in the coastal districts of South India, Chittagong, and the Andaman Islands. The cellular pericarp is full of a black, caustic, oily juice which is a powerful rubefacient and vesicant. It contains the phenolic compound cardol, anacardic acid and an ether-soluble substance to which cantharidin-like effects of the oil are attributed (Joseph and Sudborough⁷). The juice from the pericarp and trunk is very caustic and produces blisters. The nut within which is the kernel (the cashew nut) must be roasted to get rid of the poisonous substance. The fumes arising from their roasting are very irritating.

ANAGALLIS ARVENSIS Linn. English—*Bird's eye*, *Red chick weed*, *Shepherd's calandar*, *Shepherd's delight*; (H.—*Jonkhmari*). It is an erect or procumbent annual found over the greater part of India ascending to an altitude of 8,000 ft. in the Himalayas. The red flowered variety is found in Kashmir, but the blue-flowered one is more common in India. The herb (Wehmer⁸), contains two glycosidic saponins while the root contains cyclamin which is also a glycoside. The leaves cause dermatitis.

ANTHEMIS COTULA Linn. It is a foetid-smelling, acrid, erect annual herb found in Baluchistan and probably in Sind also. The fresh plant yields 0.01 per cent. and fresh flowers about 0.013 per cent. of an essential oil (Hurd⁹). The leaves and flowers cause dermatitis.

* *APIUM GRAVEOLENS* Linn. (Wild form).

* *ARISAEMA SPECIOSUM* (Wall.) Mart.

ARISAEMA TORTUOSUM (Wall.) Schott.

ASPARGUS OFFICINALIS Linn. English—*Asparagus*, *Sparrow grass*; (H.—*Halyun*; B.—*Hikua*). Young stems are said to produce dermatitis.

* *CALOTROPIS GIGANTEA* (Linn.) Dryand.

CALOTROPIS PROCERA (Linn.) Dryand. (H.—*Ak*, *Madar*, *Mandara*; S.—*Alarka*; Bo.—*Mandara*). It is a shrub found more or less throughout India in warm and dry places from the North-West Frontier Province of Pakistan and in the Punjab to western, central and southern India; it occurs abundantly in sub-Himalayan tracts and the adjacent plains in the north-west. The milky juice contains a proteolytic enzyme and a toxic substance (Gerber and Flourens¹⁰). It also contains a highly active resin (Gerber and Flourens¹¹). The root bark contains a bitter yellow resin but no alkaloid (Sharma¹²). Milky juice produces dermatitis. A child about three years old, accidentally during play brought the juice in contact with his prepuce. He was brought to the hospital two days afterwards. The part was very much swollen and there were patches of ulceration with narcosis. The patient had difficulty in passing urine. On circumcision the glans penis was also found to be swollen and ulcerated.

* *CANNABIS SATIVA* Linn.

CISSUS SETOSA Roxb. syn. *VITIS SETOSA* Wall. English—*Hairy wild vine*; (H.—*Harmal*; Bo.—*Khajoli-chavel*.) It is a shrub found in western India from the Circars and Mysore southwards. Juice causes dermatitis.

* *Datura stramonium* Linn.

DAUCUS CAROTA Linn. English—*Carrot*; (H., Bo. & P.—*Gajar*; S.—*Shikha-mulam*). It is a hispid biennial herb cultivated throughout India as an article of food. The fruit of the cultivated carrot yields 1 to 1.5 per cent. of an essential oil containing 1- α -pinene and a crystalline body named daucol (Finnemore¹³). The leaves contain the two bases pyrrolidine and daucine (Pictet and Court¹⁴) besides an essential oil. It has been stated that some persons develop dermatitis on coming in contact with carrot leaves especially when they are wet.

DELPHINIUM AJACIS Linn. It is cultivated in gardens. The seeds contain two alkaloids, crystalline ajacine and crystalline ajaconine (Wehmer⁸). Leaves and seeds cause dermatitis.

DICTAMNUS ALBUS Linn. English—*Bastard dittany*, *Fraxinella*, *White dittany*. It is a strong-smelling shrubby plant met with on the temperate western Himalayas from Kashmir to Kunawar at altitudes of 6,000 to 8,000 ft. It is very common in Pangi. The roots contain an ethereal oil, a bitter substance, a saponin, a crystalline dictamnolacton (probably identical with evodin), a crystalin toxic alkaloid dictamnine and also a phenolic substance. The flowers contain 0.05 per cent. and leaves 0.15 per cent. of an essential oil (Wehmer⁸). The leaves and capsules cause dermatitis.

ERIGERON CANADENSIS Linn. English—*Cobbler's pegs*, *Canada fleaband*; (Kash.—*Kach*). It is an annual herb found in the western Himalayas, Punjab and Rohilkhund up to an altitude of 4,000 ft. It is plentiful in certain valleys in Kashmir. It is also found in Shillong (Assam) and on the Western Ghats and Nilgiris up to 6,000 ft. above sea level. The fresh leaves contain 0.33 to 0.66 per cent. and dry leaves 0.26 per cent. of an essential oil (Wehmer⁸, Rabak¹⁵). Tannic acid and gallic acid have also been isolated from the leaf (Wehmer⁸). The leaves cause dermatitis. The oil has an acrid taste and causes smarting of the eyes and soreness of the throat. The leaves produce irritation of the parts of the body coming in contact with the plant. When powdered the leaves produce a dust which is irritating (Pammell¹⁶).

EUPHORBIA ACAULIS Roxb. syn. *E. FUSIFORMIS* Buch.-Ham. It is found in the tropical Himalayas, Oudh, Bengal and western India. The milky juice is very acrid and vesicant.

EUPHORBIA ANTIQUORUM Linn. (H.—*Tridhara-sehund*; S.—*Vajrakantaka*; B.—*Tiktasij*; Bo.—*Naraseja*). It is a large shrub or a small tree found in dry places throughout the hotter parts of India ascending to an altitude of 2,000 ft. It is also occasionally cultivated as hedge plant in villages. The Milky juice is intensely irritant. During the collection of juice by the present authors, the person employed for the purpose complained bitterly of itching all over the face, which was also considerably swollen. The trouble, however, was relieved by the application of soothing preparation for a couple of days.

EUPHORBIA CATTIMANDO W. Elliot (*E. trigona* F. Brit. Ind. in part). It is an erect shrub found on the dry rocky hills in the Deccan and probably other parts of India. It contains euphorbon (Henke¹⁷). Milky juice which is vesicant in fresh condition.

EUPHORBIA HELIOSCOPIA Linn. English—*Cat's milk*, *Sun spurge*, *Wartwort*; (H.—*Hirru-seeah*; P.—*Ganda buti*). It is an annual herb which is a common field weed in spring throughout the plains of the Punjab and the Siwalik tract, ascending to 8,000 ft. in the outer Himalayas. It is also found wild in the Nilgiris where it has been introduced. The fresh herb contains a non-haemolytic substance (Gonnerman¹⁸). The seeds contain 32.6 per cent. of a fatty oil the physiological action of which is due to powerful purgative principle (Gillot²⁰). Dymock¹⁸ reports a case of severe ulceration resulting from the application of a poultice made from the bruised plant.

EUPHORBIA NERIIFOLIA Linn. (H.—*Sehund*; S.—*Snuhi*; B.—*Mansa-sij*; Bo.—*Minguta*). It is a large fleshy shrub occasionally planted in villages as a hedge plant throughout India and is sometimes found wild on waste land. In Orissa and in the Deccan it

is said to occur in a state of nature in rocky places. The milky juice is rubefacient and acrid.

EUPHORBIA NIVULEA Buch.-Ham. (H. & B.—*Sij*; Bo.—*Newrang*; S.—*Patta karie*). It is a large shrub or a small tree found in dry rocky places in northern, central and southern India. Milky juice produces dermatitis.

EUPHORBIA PEPLUS Linn. It is probably an introduced species. The herb contains 4.8 per cent of an oleo-resin (Vevey²¹). It also contains neutral and acid saponins with haemolytic properties (Gonnerman¹⁹). The milky juice causes dermatitis.

EUPHORBIA ROTHIANA Spreng. It is found in central, western and southern India. The milky juice causes dermatitis.

EUPHORBIA ROYLEANA Boiss. (H. & P.—*Shakar pitam*, *Thor*). It is a fleshy shrub common on the dry and hot rocky slopes of the outer ranges of the western Himalayas from the Indus to Kumaon ascending to an altitude of 6,000 ft.; it occurs on the salt range in the Punjab. It is also commonly grown in the form of hedge in the sub-Himalayan tract and the adjacent plains. The milky juice causes dermatitis. It is very injurious to the eyes.

EUPHORBIA THOMSONIANA Boiss. (Kash.—*Hirtis*). It occurs in Western Tibet, Kurrum Kashmir (Gilgit), etc., at altitudes of 10,000 to 12,000 ft. The milky juice causes dermatitis.

EUPHORBIA TIRUCALLI Linn. It is an unarmed shrub or a small tree which is a native of Africa and has become naturalized in several places in India. It is often grown as hedge or occasionally as a road-side tree. The milky juice contains about 20 per cent. of resins (Wehmer⁸). The milky juice is rubefacient and vesicant. It produces severe inflammation and excruciating pain if it gets in touch with the skin or into the eyes. It is said to be used by criminals to destroy the eyes of domestic animals.

EUPHORBIA TRIGONA Haw. (*E. trigona* Fl. Brit. Ind., in part). It is an erect glabrous shrub, found in the dry rocky hills in the Deccan. The milky juice contains euphorbon, resin, rubber-like substances and malic acid (Wehmer⁸). The milky juice is acrid and in fresh condition is vesicant.

EXCOECARIA AGALLOCHA Linn. English—*Blinding tree*; (B.—*Gangwa*; Bo.—*Geva*). It is a small tree found in tidal forests and swamps on all the coasts of India. The fresh sap is extremely acrid and causes intolerable pain if it accidentally gets into the eyes, which sometimes happens to wood cutters when the tree is cut for fuel; hence the name 'Excoecaria'. It blisters the skin and produces sores.

FAGOPYRUM ESCULENTUM Moench. English—*Buckwheat*, *Brank*; (H.—*Kotu*, *Kaltu*, *Phaphra*; P.—*Darau*, *Phaphkar*, *Obal*; Kash.—*Trumba shrin*). It is an annual herb extensively cultivated in the Himalayas and sub-Himalayan tracts and in Western Tibet at altitudes of 2,000 to 12,000 ft.; also in the Khasia Hills, Manipur, as well as in the hilly districts of central and southern India. The herb contains the glycoside rutin, the seeds contain a substance which is toxic to lower animals (Ohmke²²). The roots are said to contain oxymethyl anthraquinones. All parts of the plant, whether dry or fresh, are capable of producing photosensitization (fagopyrism) in animals, the fresh plant in the flowering stage being considered most toxic. The symptoms are: Inflammatory swelling accompanied by severe itching of the ears, face and eyelids, spreading on to the submaxillary region and neck. In severe cases vesicles containing yellowish fluid appear on the affected part. These vesicles may become infected with bacteria and give rise to purulent and even necrotic dermatitis. Among human beings certain individuals are known to be sensitive to buckwheat. They experience severe itching and develop a rash from eating food made from buckwheat flour. (Maurin²³ 24).

FLEURYA INTERRUPTA Gaudich. (H.—*Lal bichua*). It is an erect herb found in Bihar, central Bengal and Khasia Hills. In Bombay State it is met with in Konkan, southern

Mahratta Country and Kanara. In the Presidency of Madras it has been reported from the hills south of Mysore at altitudes of 5,000 to 6,000 ft. above sea level and also from the Rampa hills of the Eastern Ghats. The stinging hairs on plant cause dermatitis.

GINKGO BILOBA Linn. English—*Maiden-hair tree*. Rarely cultivated in gardens. The leaves contain five crystalline substances and also shikimic acid. The seeds contain ginkgol acid, two alcohols, ginnol and bilobol, and also asparagin (Wehmer⁸). The seeds cause dermatitis.

GIRARDINIA HETEROPHYLLA Decne. The varieties *zeylanica* and *palmata* of the Flora of British India are now considered by several botanists as distinct species, viz., *G. zeylanica* Decne, and *G. leschenaultiana* Decne, respectively. *G. zeylanica* is found in the south western hilly portion of the Uttar Pradesh and extends through Chota Nagpur, Mt. Abu, Konkan and the Deccan to the hills of southern India and the west coast of Madras Presidency from 1,000 to 5,000 ft. above sea level. *G. leschenaultiana* is more restricted in its distribution and is found on the mountains of the Western Ghats at altitudes of 4,000 to 7,000 ft. Both these are known as Nilgiri nettle while the name Himalayan nettles is restricted to *G. heterophylla*. It is a perennial herb found in the subtropical and temperate Himalayas from Kashmir to Sikkim, up to 7,000 ft. above sea level; also in Assam and the Khasia hills. The stinging hairs on the plant cause dermatitis.

HEDERA HELIX Linn. English—*Barren ivy, Creeping ivy, Ivy*; (H.—*Lablab*; P.—*Banda*; Kash.—*Karmora*). It is an evergreen climbing shrub found in the Himalayas from 6,000 to 10,000 ft. above sea level and in the Khasia Hills from 4,000 to 6,000 ft. Nearly all parts of the plant, viz. leaves, fruits and seeds contain the glycoside a-hederin and probably certain other glycosides²⁵. Leaves produce dermatitis.

HIPPOMANE MANCINELLA Linn. English—*Manchineal tree*. It is a much branched tree introduced from America; it is now occasionally cultivated in Indian gardens. It contains acrid milky juice (Wehmer⁸) which causes dermatitis.

HOLIGARNA ARNOTTIANA Hook. f. (Bo.—*Bibu*). It is a tall tree found in the evergreen forests on the Western Ghats from the Konkan southwards. The juice produces dermatitis. In some persons it produces blisters, while others are immune. The tree is dreaded by the local people.

HOLIGARNA GRAHAMII (Wight) Hook. f. (Mar.—*Bilwuli, Bipte*). It is a tree found in Western India. The juice has properties similar to those of *H. arnottiana*.

HOLIGARNA LONGIFOLIA Buch.-Ham. ex Roxb. (B.—*Barola*; Bo.—*Hulugiri*). It is a tall tree native of Eastern Bengal and Chittagong. The juice is of a powerfully caustic nature and blisters the skin.

HUMULUS LUPULUS Linn. English—*Hops*. It is cultivated in the north west Himalayas. The active principles constitute the lupulin. Leaves cause dermatitis.

HYPERICUM PERFORATUM Linn. English—*St. John's grass, St. John's wort*; (H. & P.—*Bassant*). It is a perennial herb found in the western temperate Himalayas from Kumaon between 6,000 to 9,000 ft. to Kashmir between 3,000 to 6,500 ft. above sea level. The herb contains tannins and 0.065 per cent. of an essential oil (Zellner and Porodko³⁴). Several investigators have reported that the plant in the flowering stage, if eaten in large amounts by livestock, leads to photosensitization and consequent dermatitis of the unpigmented portions of the skin. Animals having pigmented skins or those not exposed to bright sunlight do not develop any symptoms but white-skinned horses, cattle and sheep develop characteristic symptoms. The toxic substance, it appears, acts upon the nerve-endings so as to photosensitize them and if the animal is subsequently exposed to strong sunlight, it develops dermatitis including blistering of the skin and falling off of the hair.

- LAPORTEA CRENULATA** Gaudich. English—*Devil nettle*, *Elephant nettle*, *Fever nettle*; (H.—*Utijun*; Bo.—*Chorpatta*). It is a stinging shrub or a small tree found in the tropical Himalayas from Sikkim eastward, also in Assam and the Khasia Hills. In the Madras State it is found in the Western Ghats at altitudes of 1,000 to 5,000 ft. and in Rampa Hills at 2,500 ft. above sea level. According to Smith²⁰ the toxic principle is formic acid but the authors have not been able to confirm this by reference to original papers consulted by them. The stinging hairs on the plant cause dermatitis. It is perhaps the worst of all the stinging nettles found in India. A contact with the hairs produces severe burning pain which may last for several days and is said to be greatly aggravated by the application of water. The sting is particularly powerful during the flowering season when it is said to bring on violent sneezing, sleeplessness and fever, hence the local English names (*Fever nettle*, *Devil nettle*) by which the plant is known to coffee planters and other English residents. Haines³ remarks that while cutting coupe lines in November in the Sikkim Terai, where it is sometimes gregarious, his coolies were attacked with sneezing, violent catarrh and ultimately vertigo, apparently from inhaling numerous minute hairs.
- LAPORTEA TERMINALIS** Wight. It is an erect herb found in the subtropical Himalayas from Kumaon to Mishmi at altitudes of 4,000 to 8,000 ft., in the Madhya Pradesh at altitudes of 4,000 to 6,000 ft., and in the evergreen forests of the Western Ghats of the Madras State at altitudes of 5,000 to 7,000 ft. It is also found in the Nilgiris. The stinging hairs on plant cause dermatitis.
- LASIOSIPHON ERIOCEPHALUS** Decne. English—*Woolly-headed gnidia*; (Bo.—*Rametha*). It is a shrub, sometimes a small tree, found in the open forests of the Western Ghats of Bombay and Madras States ascending to an altitude of 7,000 ft. in the Nilgiris. The bark (and perhaps the leaves also) is powerfully vesicant. The collector of the bark for examination by the present authors complained bitterly of a burning sensation in the eyes, nostrils and face during packing of the dried bark in bags. This sensation lasted, more or less, for three days.
- LEONURUS CARDIACA** Linn. It is a herb found in temperate Western Himalayas from Kashmir to Kumaon at altitudes of 6,000 to 10,000 ft. The herb contains an amorphous bitter substance leonurin (Wehmer⁸). The leaves produce dermatitis.
- LOBELIA EXCELSA** Lesch. It is a herb which grows on the Western Ghats of South India, the Nilgiris, Pulney Hills and hills of Travancore at altitudes of over 5,000 ft. The milky juice causes dermatitis.
- LOBELIA NICOTIANAÆFOLIA** Heyne. English—*Wild tobacco*; (H.—*Nala*, *Narasala*; B.—*Badanala*, *Nala*; Bo.—*Bokenal*, *Dhavalala*). It is a herb found on the Western Ghats from Bombay to Travancore at altitudes of 3,000 to 7,000 ft. above sea level and is met with in Konkan, the Deccan, the Nilgiris, Malabar, etc. The leaves contain two alkaloids one of which resembles lobeline from *L. inflata* Linn. (Dragendorff and Rosen²⁷). The milky juice causes dermatitis. The dust from the powdered herb irritates the nostrils in the same way as tobacco.
- MUCUNA ATROPURPUREA** DC. It is a woody climber found in the plains of western India.
- MUCUNA GIGANTEA** DC. English—*Elephant cowitch*; (Mal.—*Kakavalli*; Tam.—*Kalgaivalli*; Tel.—*Enugadul agondi*). It is a woody climber found in the plains of western India.
- MUCUNA HIRSUTA** Wight & Arn. It is an annual climber found in the plains of western India.
- MUCUNA MONOSPERMA** DC. English—*Negro bean*; (Bo.—*Sonogaravi*, *Mothi-kuhili*). It is a woody climber of the eastern Himalayas and Khasia Hills also met with in Assam, Chittagong, and the hills of western India.
- MUCUNA PRURITA** Hook. (*M. pruriens* Fl. Brit. Ind., non DC). English—*Cowhage*, *Cwitch*; (H.—*Kiwach*; S.—*Atmagupta*; B.—*Alkushi*; Bo.—*Kuhili*). It is an annual climber found in the Himalayas and the plains. The rigid pointed hairs on the pods if touched enter the skin and produce itching. The action appears to be purely mechanical.

* *PODOPHYLLUM HEXANDRUM* Royle syn. *P. emodi* Wall. ex Hook. f. & Th.

POLYGONUM HYDROPIPER Linn. English—*Biting peeper, Smart-weed*; (B.—*Packur-mul*).

It is a herb found in wet places more or less throughout India, ascending to an altitude of 7,000 ft. in the Himalayas. The herb contains formic acid, acetic acid and baldrionic acid, much tannin and small amounts of an essential oil (Steenhauer²⁸). The root is said to contain oxymethyl-anthraquinones (Maurin^{23, 24}). The fresh plant contains an acrid juice which causes irritation and smarting when brought into contact with the nostrils or eyes. The bruised leaves as well as the seeds will raise blisters if employed as a poultice, as in the case of mustard poultice.

RANUNCULUS SCLERATUS Linn. English—*Marsh crowfoot, Water celery*; (Kum.—*Shim*; Pers.—*Kabikaj*). It is an erect annual herb met with on river banks in Bengal and northern India, in the marshes of Peshawar and in the warm valleys of the Himalayas. It appears during the cold weather and remains until the break of the rains. The plant contains anemonin, anemon acid and an essential oil (Wehmer⁸). The leaves cause dermatitis. The fresh plant is highly acrid. The bruised leaves when applied to the skin raise blisters and were formerly used in Europe by professional beggars to produce or maintain blisters or open sores to excite sympathy.

RHUS INSIGNIS Hook. f. (Lep.—*Sehr*; Nep.—*Kagphulai*). It is a small tree found in the interior valleys of the Sikkim Himalayas at altitudes of 3,000 to 6,000 ft., and in the Khasia Hills at 4,000 ft. The leaves, bark, fruit produce dermatitis. The juice is a powerful vesicant.

RHUS PUNJABENSIS J.L. Stew. ex Brand. (P.—*Arkhar, Kakkrein, Titari*). It is a small or medium-sized tree found in the north-western Himalayas at altitudes of 2,500 to 8,000 ft. from the Indus eastwards and is common in the inner ranges in moist ravines, etc. Leaves, bark and fruit produce dermatitis. The juice is vesicant.

RHUS SUCCEDANEA Linn. English—*Crab's claw, Japan wax tree, Red lac sumach*; (H.—& B.—*Kakra-singi*; Bo.—*Takada-singi*; P.—*Arkhol*). It is a medium sized tree found in the temperate Himalayas from Kashmir to Sikkim and Bhutan at altitudes of 3,000 to 8,000 ft. It also occurs in the Khasia mountains between 2,000 and 6,000 ft. and in Sind. The leaves contain about 20 per cent. of tannin. The milky juice yields a lac similar to Japan lac with laccol, a toxic phenol. Laccol is identical with urshiol (Wehmer⁸). Leaves, bark and fruit produce dermatitis. The juice is a vesicant.

RHUS WALLICHII Hook. f. (H.—*Akoria*; Nep.—*Chosi*; P.—*Arkhar, Arkol*). It is a small tree found in the temperate Himalayas from Garhwal to Nepal, occurring at altitudes of 6,000 to 7,000 ft. above sea level. Leaves, bark and fruit produce dermatitis. The juice possesses vesicant properties.

RUMEX ACETOSA Linn. It is a perennial herb met with in the western Himalayas from Kashmir to Kumaon at altitudes of 8,000 to 12,000 ft. The plant contains oxalates as well as free oxalic acid (Berthelot and Andre³⁰; Fleury³⁵). It contains acid potassium oxalate and some tartaric acid (Watt et al²⁹). Purdie³¹ found 1.36 per cent. of potassium binoxalate in the juice. Maurin²³ reports 1.05 per cent. of oxymethyl anthraquinone from the roots and traces of the same from the leaves. The leaves produce dermatitis in susceptible persons.

RUMEX ACETOSELLA Linn. English—*Field sorrel, Sheep's sorrel, Sourack*; (B.—*Chukapalam*; S.—*Chutrika*). It is a perennial herb found in the eastern Himalayas in Sikkim at altitudes of 7,000 to 8,000 ft. The herb contains oxalates as well as free oxalic acid. It also contains potassium binoxalates (Orlandini³²). The leaves produce dermatitis.

RUTA GRAVEOLENS Linn. var. *ANGUSTIFOLIA* Hook. f. English—*Common rue, Country-man's treacle, Garden rue*; (H.—*Pismarum, Sadab*; B.—*Ermal, Ispund*; Bo.—*Satap*). It is occasionally cultivated in gardens. It contains an essential oil. The leaves produce dermatitis. If much handled they produce redness, swellings and even vesication of the part with which they come in contact.

SAPIUM INSIGNE Trimen. (VERN.—*Khinna*; Bo.—*Dudla*; P.—*Biloja*, *Dudla*). It is a small or middle-sized tree found in the sub-Himalayan tract and outer Himalayas from the Ravi eastwards to Bhutan (not in Sikkim) ascending to an altitude of 5,500 ft.; also in Assam, Chittagong and Orissa. In western and southern India it is common near the sea coast of Konkan and North Kanara, and is also found in the Deccan, hills of Kurnool, Cuddapah and Nellore, Kambakan Hill in Chingleput, Western Ghats and West coast. It is usually found in rocky places up to 6,000 ft. above sea level. Its milky juice is acrid and acts as a vesicant.

SCHIMA WALLICHII Choisy. (H.—*Chilauni*, *Makusal*). It is a large evergreen tree of the eastern Himalayas, from Nepal and Sikkim to Bhutan, found at altitudes between 2,000 and 5,000 ft. It also occurs in Assam, the Khasia Hills and Chittagong. Leaves contain saponin (Wehmer⁸). The bark, in which the liber cells appear like glistening-white needles irritates the skin in the same way as cowhage (*Mucuna pruriia*).

* **SEMECARPUS ANACARDIUM** Linn. f.

SEMECARPUS TRAVANCORICUS Bedd. (Mal.—*Azukaram*; Tam.—*Kattu-shenkottai*; Tel.—*Natu sengota*). It is a very large tree found in the evergreen forests of Tinnevely and Travancore up to an altitude of 4,000 ft. The juice produces dermatitis.

TRAGIA BICOLOR Miq. It is a slender climbing herb found in the Western Ghats, the Nilgiris and Pulney Hills at an altitude of 5,000 to 6,000 ft. in Shola forests. The stinging hairs on the plant produce dermatitis.

TRAGIA INVOLUCRATA Linn. With varieties in the Flora of Brit. Ind. which are now treated as distinct species, viz. *T. hispida* Willd., *T. muellerian* Pax, and Hoff., *T. canabina* Linn. f. and *T. montana* (Thw.) Muellarg. It is a perennial twinning herb found throughout India from the Punjab and the outer Himalayan ranges eastward to Assam, and southward to Travancore. The stinging hairs on plant produce dermatitis.

URTICA DIOICA Linn. English—*Common nettle*, *Stinging nettle*; (H. & P.—*Bichu*, *Bichua*). It is an erect herb found in the north-west Himalayas from Kashmir and the Salt Range to Simla at altitudes of 8,000 to 10,700 ft. and in Western Tibet at altitudes of 8,000 to 12,000 ft. The plant contains lecithin and a glycoside (Wehmer⁸). According to Cleery⁴ the protoplasm of hairs has an alkaline reaction and encloses an acid cell sap. The cell sap contains a small amount of formic acid as well as acetic, butyric and other volatile fatty acids. The specific poison of the cells which is a non-volatile substance of an acid nature allied to the resin acids, is in solution in these acids. The stinging hairs on plant produce dermatitis.

URTICA HYPERBOREA Jacq. (Ladd.—*Dzatsuit*, *Stokpotsoöma*, *Zatud*). It is a low, densely tufted under shrub found in Western Tibet at altitudes of 12,000 to 17,500 ft. and in Eastern Tibet between altitudes of 16,000 to 17,000 ft. The stinging hairs on plant produce dermatitis.

URTICA PARVIFLORA Roxb. (Kum.—*Berain*, *Bichhu*, *Shisona*). It is a slender herb found in the temperate Himalayas from Kashmir to Mishmi between altitudes of 5,000 to 12,000 ft. The flora of British India also records it from Ootacamund in the Nilgiris. The stinging hairs on plant produce dermatitis.

URTICA PILULIFERA Linn. English—*Roman nettle*. It is a common European stinging weed occurring occasionally near Simla and elsewhere near habitations in the hills. The seeds contain a fatty oil and a glycoside (Wehmer⁸). The stinging hairs on the plant produce dermatitis.

WALLICHIA DISTISCHA T. Anders. (Lep.—*Katong*). It is a handsome palm of the outer hills of Sikkim. Berries and perhaps also the leaves produce dermatitis (Watt⁸³).

* **XANTHIUM STRUMARIUM** Linn.

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C. REPUTED ABORTIFACIENT AND EMMENAGOGUE PLANTS

Abortifacients are drugs or agents that cause abortion, *i.e.*, the expulsion of the foetus prematurely, particularly at any time before it is viable, or capable of sustaining life. The gestation period, *i.e.*, the carrying period of the young in the womb from conception to delivery, varies in different animals and so far as human beings are concerned, the term abortion usually implies the expulsion of the foetus during the first six months of pregnancy. Expulsion of the foetus after the six months when it is viable but before the normal period of nine months, is generally termed premature delivery or labour. The popular term miscarriage is usually applied to an abortion before the sixth month, occasionally before the sixth week of gestation, and rarely even to a premature labour. In law, however, the term abortion usually implies criminality in producing miscarriage for an improper purpose at any time of gestation short of full term, and means pre-meditated or intentional abortion produced by artificial means, solely for the purpose of preventing the birth of a living child; it is designated as criminal abortion.

For our purpose it would be convenient to divide into three categories, viz. (a) natural abortion, (b) artificial abortion, and (c) criminal abortion or foeticide. The causes responsible for naturally occurring cases of abortion are various. They may be due to the poor condition of the mother's blood or poisons circulating in the same mechanical disturbances of the circulation, diseases of the genito-urinary organs, over-indulgence in sexual intercourse by the mother during pregnancy, nervous causes, syphilis, streptococcal infections, etc. Abortion may also naturally be due to the disease of the membranes of the ovum or foetus or diseases of the embryo itself. In certain cases the law permits the induction of premature labour and abortion if competent medical opinion decides that the life of the mother is in danger. This, however, is not resorted to unless all other means for preserving the life of the mother, and if possible that of the child also, have failed. Criminal abortion is, for a variety of reasons, induced with the sole object of unlawfully destroying the impregnated ovum or the foetus, and the law holds the attempt to do so equally guilty with the actual accomplishment. It has no moral, religious, social or legal sanction. Nevertheless, criminal abortion is undoubtedly prevalent in India as in other countries, although only relatively a small proportion of the cases are brought to light. Although no reliable statistics are available, it could perhaps be said with certainty that, on account of increase in population and the consequent ever-increasing struggle for existence together with a continued demand for higher standard of living, it is the married couples who are most frequent perpetrators of this nefarious crime. Many a parent can ill-afford the educational and other expenses of a large number of children and simultaneously maintain the social position to which they belong. They feel the inconvenience of supporting a large family and, without any compunction, conspire to get rid of their unborn baby. On the other hand, unmarried

girls and widows, to get rid of the fruits of illicit intercourse and to hide the shame of their illegitimate pregnancy, also form a considerable percentage of these criminals.

Owing to the advent of various kinds of the so-called contraceptives it could be safely deduced that the necessity and frequency or resorting to abortion is on the decrease. These appliances for the prevention of fertilization of the ovum are, however, beyond the means of a vast majority of Indians, whose economic condition is very low. On the other hand, the use of the so-called infallible contraceptives by the married as well as the young, unmarried, inexperienced girls has not infrequently led to undesired pregnancy. As soon as suspicion is aroused with regard to the condition of the female—after the omission of one menstrual period, the urge of getting rid of the 'unwanted arrival' begins to get strong and the advice of confidential friends is sought. Usually some drugs are recommended which are tried at first. Generally, however, they prove ineffectual; and then active steps are taken to enlist the services of professional abortionists. These abortionists vary greatly in education and technical skill. Some are well qualified for the purpose, while others, such as most of the dais or country midwives who mainly use drugs of vegetable origin or rash mechanical means, are quite ignorant of aseptic precautions and of the rudiments of anatomy. The patient sometimes learns from an abortionist a method of direct interference with the uterus, and if this is successful, she proceeds to apply it herself when another occasion arises. Often the woman does not realize the condition of her pregnancy till between the fourth and fifth months, when owing to the symptoms of quickening, she can no longer remain ignorant. At whatever time of gestation abortion is resorted to, it is attended with grave risk to the life of the unfortunate mother, unless it is performed by highly qualified gynaecologists. Since the services of expert gynaecologists are not easily available for the purpose of criminal abortion, the patient usually falls into the hands of quacks and often dies.

Criminal abortion endangers the mother's life by causing profuse haemorrhage as a result of retention of the placenta or some other product of conception, or by septic inflammatory processes. In the case of abortion, which is procured through the agency of various instruments, perforation into the peritoneal cavity and septicaemia are the usual causes of death. It is interesting to note that more women die during attempt to procure criminal abortion than from childbirth and its complications. Peritonitis is the most common cause of death and is responsible for more than half the fatal cases. General septic infection kills about one-fourth. The remainder die from embolism, pneumonia or some other incidental infection (Davis²⁰). Serious illness after criminal abortion is very common. It is popularly believed that the earlier the period at which abortion is procured, the lesser is the danger to the life of the mother. This is not true. During the early gestation period the contractile powers of the muscles of the uterine walls are limited and hence the chances of haemorrhage great owing to the non-occlusion of the bleeding vessels. At or near the completion

of the term they are able to contract firmly and so occlude the bleeding vessels. Furthermore, if the uterus has not contracted thoroughly, the open sinuses are liable to absorb septic matter, so that septic infection is of much more frequent occurrence if the abortion occurs during the earlier periods of pregnancy than after delivery at the full term.

METHODS OF PROCURING ABORTION.—The methods of procuring abortion are varied. Among these may be mentioned severe exercise, violent shaking of the body, tight lacing of the abdomen, and even trampling or kicking of the abdomen or other severe violent means. Mechanical means are also applied with a view to disturb the relation between the uterus and its contents, and are usually quite effective although usually accompanied with grave danger to the mother's life. For this purpose various kinds of instruments such as wires, bones, twigs, etc. are used with the object of perforating the membrane surrounding the foetus. In India, quite a large number of 'dais', who practise the unlawful trade, introduce into the vagina or the os of the uterus sticks from six to eight inches long, which are commonly known as 'abortion sticks'. One end of these sticks is wrapped round with a piece of rag or cotton wool soaked with the juice of such plants as *madar*, *Calotropis procera* (Linn.) Dryand. and *C. gigantea* (Linn.) Dryand., marking nut (*Semecarpus anacardium* Linn. f.), jequirity (*Abrus precatorius* Linn.), etc.; other ingredients of medication used for abortion sticks are arsenious oxide, orpiment and red lead. Some of the plants, the irritant twigs of which are similarly used, are *Plumbago indica* Linn. (*P. rosea* Linn.), *P. zeylanica* Linn., euphorbiaceous plants, and less frequently *Nerium indicum* Mill. (*N. odorum* Soland). These twigs are frequently smeared with asafoetida prior to introduction. The oral administration of reputed abortifacient drugs is, however, more frequently resorted to than any other method for procuring abortion.

ORAL ADMINISTRATION OF ABORTIFACIENT PLANTS.—It may be stated at the outset that administration of the so-called abortifacient drugs seldom answers the purpose for which they are used. When the desired object is attained, it is generally from the use of a poisonous quantity, so that when the abortion is procured it is often followed by dangerous poisoning or death of the mother; not infrequently the mother dies without the production of abortion at all. It may be noted that all poisons, when taken in sufficiently large doses, may act as abortifacients, but such doses are generally attended with grave risks to the life of the mother. Some of the plants used as abortifacients are supposed to produce uterine contractions which expel the contents of the gravid uterus; these are called ecbolics. Others, when used in the non-gravid condition, are supposed to promote menstrual flow or to re-establish it after its arrest from causes other than pregnancy; these are called emmenagogues. Still others have poisonous effects on the system generally.

The drug that enjoys the greatest reputation as an ecbolic is ergot, which is the sclerotium of the fungus *Claviceps purpurea* Tulasne, developed in the ovary of rye, *Secale cereale* Linn. It is a well-known medicine for exciting

uterine contractions. It may be noted that while ergot is certainly capable of producing contractions of the uterus during the later stages of pregnancy, it is doubtful whether it can initiate uterine contractions in women during the early stages, or produce them with sufficient force so as to cause the expulsion of the foetus. Some observers are of the opinion that ergot acts upon the uterus only when natural contractions of this organ have already begun; but, since uterine contractions normally occur during pregnancy it is conceivable that ergot may be able to augment the force of these contractions although in the early months of pregnancy it may not be able to increase them sufficiently to procure abortion. Quinine from species of *Cinchona* is another drug which stimulates the contractions of the uterus when given in large doses; abortions have occasionally occurred after its use in malaria, while in other cases labour pains may be induced. Therapeutic doses, however, do not in most cases suffice to excite persisting activity in the quiescent gravid uterus, and are, therefore, not reliable for inducing premature labour, but if weak contractions are present, they are intensified. Like ergot it is conceivable that quinine may be able to augment the normal contractions of the uterus during pregnancy, but it may not be able to increase them sufficiently to procure abortion.

The emmenagogues, which often increase the menstrual flow in the non-gravid uterus, are very largely employed to induce abortion. They include all well-known drastic purgatives, such as aloes (*Aloe barbadensis* Mill.), and irritant volatile oils, such as pennyroyal (*Mentha pulegium* Linn.), savin (*Juniperus sabina* Linn.), tansy (*Tanacetum vulgare* Linn.). These are all intestinal irritant, and produce violent gastro-enteritis (nausea, vomiting and diarrhoea). If the poison acts only when dissolved and is insoluble in the stomach, as in croton oil (from *Croton tiglium* Linn.), the nausea and vomiting may not be present, but only the diarrhoea. The hyperaemia produced is not confined to the intestines, but all the neighbouring abdominal organs partake of the congestion, although they do not come in direct contact with the irritant. It must be remembered that these emmenagogues produce their ecboic effect only secondarily to the gastro-enteritis; the latter may be so violent as to be fatal without accomplishing the desired result. None of the intestinal irritants (drastic purgatives and irritant volatile oils) are suitable for procuring abortion and should never be employed as ecboics. The volatile oils may, however, be useful as emmenagogues. Besides the ecboics and emmenagogues, some general poisons, such as Indian oleander (*Nerium indicum* Mill. syn. *N. odorum* Soland.), are also administered in India for procuring abortion. There does not appear to be any basis for their use, except that by acting as general poisons they may occasionally achieve abortion. There is always a grave risk to the life of the mother when these plants are employed.

A perusal of the above will show that there is no reliable plant or its product for procuring abortion, without endangering the mother's life. Despite this, the fact remains that ignorant persons do employ sometime or the other a number of such plants to achieve the object. Chopra and Badhwar¹ have published

a comprehensive list of Indian plants poisonous to man, livestock, insects and fishes. Their studies have revealed that a large number of plants are used in India for the purpose of procuring criminal abortion. Here we are going to deal with Indian plants which are applied locally on account of their irritant juices or are administered orally to procure abortion. A list of such plants, their important English and vernacular names, distribution, chemical constituents, properties and methods of use are briefly discussed. Only plants indigenous to or cultivated in India are dealt with. Plants or their products, such as pennyroyal, savin, tansy, etc., although commonly used as emmenagogues or abortifacients in Western medicine and available at druggists' shops in India are excluded, since they do not grow in India. Further, such plants as croton, a drastic purgative found in India, will act like other drastic purgatives mentioned in the list, are also excluded, because they are not known to be used as abortifacients in this country.

Reputed Abortifacient and Emmenagogue Plants

[* For detailed description refer to Parts II and III]

* *ABRUS PRECATORIUS* Linn.

* *ALOE BARBADENSIS* Mill.

ANANAS COMOSUS (Linn.) Merr. (*A. SATIVUS* Schult. f.). English—*Pine-apple plant*; (VERN.—*Ananas, Anaras*). It is cultivated in various parts of India. Its fruit contains a digestive ferment, bromelin, which is more closely related to trypsin than to pepsin. Nothing is known regarding the presence of any poisonous chemical constituent (Wehmer²). Unripe fruit is believed to possess emmenagogue properties and is stated to be used to produce abortion. Even the juice of the ripe fruit is held by some people to have irritant action on the uterus and to have the property of producing strong uterine contractions. The juice of leaves also stated to be used as an abortifacient (Watt⁸).

* *ANNONA SQUAMOSA* Linn.

* *APTUM GRAVEOLENS* Linn.

* *ARECA CATECHU* Linn.

* *ARISTOLOCHIA BRACTEATA* Retz.

* *ARISTOLOCHIA INDICA* Linn.

* *ARTEMISIA VULGARIS* Linn.

* *CALOTROPIS GIGANTEA* (Linn.) Dryand. (*C. GIGANTEA* R. Br.).

* *CALOTROPIS PROCERA* (Linn.) Dryand. (*C. PROCERA* R.Br.).

* *CARICA PAPAYA* Linn.

* *CELASTRUS PANICULATUS* Willd.

* *CINCHONA CALISAYA* Wedd.

* *CINNAMOMUM CAMPHORA* Nees & Eberm.

* *CITRULLUS COLOCYNTHIS* Schrad.

* *CROCUS SATIVUS* Linn.

CUCUMIS TRIGONUS Roxb. (VERN.—*Bislanhi, Gomuk, Jangli-indrayan, Karit*). It is found throughout the greater part of India. The fruit contains colocynthin or a substance of a similar nature (Naylor and Chappel¹⁴). Bitter pulp is used as substitute for colocynth and is a drastic purgative. Waddel⁵ mentions a case which was reported to the Bombay Chemical Analyser's office in 1833, in which it was stated that the root of this plant had been administered for the purpose of procuring abortion.

* *CUSCUTA REFLEXA* Roxb.

* DAUCUS CAROTA Linn.

DOLICHANDRONE FALCATA Seem. (VERN.—*Bhersing, Kanseri, Mendel*). It is found in Rajasthan Bundelkhand, Bihar, Madhya Pradesh, Berar, Konkan, the Deccan, Mysore and most districts of the Madras Presidency in dry deciduous forests and often on rocky slopes. The plant is reputed to be an abortifacient though its specific abortifacient power is not known.

* EUPHORBIA TIRUCALLI Linn.

EXCOECARIA AGALLOCHA Linn. English—*Blinding tree*; (VERN.—*Gaugwax, Geon, Haro*). It is found in tidal forests and swamps on all the coasts of India. A case was reported to the authors from Bengal wherein the fresh juice of the plant was given to a pregnant woman carrying five months with a view to procure abortion, with successful results.

GARCINIA MORELLA Desr. English—*Gamboge tree*; (VERN.—*Devanahuli, Jarige, Pesupuvanna, Tamal*). It is an evergreen tree found in the forests of Eastern Bengal, the Khasia Mountains and the Western Ghats from Kanara and Mysore to Travancore. Gamboge contains 70-80 per cent. of resin, 15-20 per cent. of gums and a small quantity of vegetable debris. Resin consists of several resinic acids named as garcinolic acid also esters and neutral resins (Allen⁶). These acids form readily soluble compounds with alkalis and thus become active in the intestine. Effects resemble those of colosynth. Gum-resin is used as an abortifacient. In doses of one to five grains it has a purgative action, but cases are on record where large doses such as of one drachm have resulted in death.

* GLORIOSA SUPERBA Linn.

GOSSYPIMUM HERBACEUM Linn. English—*Cotton plant*; (VERN.—*Kapas, Rwi*). It is cultivated throughout the warmer regions of India. Root-bark contains a pale yellow or colourless acid resin to the extent of about 8 per cent. and also gossypol (Sollmann⁸). Attention appears to have been first drawn to the emmenagogue property of the root-bark from the observation of Bouchelle (Mississipi) who stated that it was used by negro women to procure abortion. There appears to be little doubt that it acts like ergot upon the uterus, and is useful in dysmenorrhoea and suppression of menstruation when produced by cold (Watt³).

LEPIDIUM SATIVUM Linn. English—*Cress*; (VERN.—*Halim*). It is cultivated throughout India. The seeds contain an essential oil (Finnemore⁹) and are used in indigenous medicine. Large doses are believed to produce abortion.

MOMORDICA CHARANTIA Linn. English—*Carilla fruit*; (VERN.—*Karela*). It is largely cultivated throughout India for its young fruits, of which there are several cultivated forms, differing in shape and size. The leaves contain a bitter substance, momordicin, resins, two resin acids, etc. (Wehmer²). Plant contains about 0.038 per cent. of an alkaloid (Luis Torres Diaz¹⁰) and the seeds yield about 32 per cent. of a purgative oil (Freise¹¹). In India, the roots stated to be used successfully for procuring abortion (Waddel⁵). A case wherein abortion was produced at the seventh month by swallowing a decoction of the roots of this plant has been reported.

MOMORDICA TUBEROSA Cogn. (M. CYMBALARIA Fenzl. ex Naud.). (VERN.—*Kadavanchi*). It is found in the western parts of India from Sattara district in the north down to Tinnevely in the South. Tubers are said to contain a bitter glycoside (Dymock et al¹²). Whole plant is acrid and the ovoid tuberous roots are reported to have been used in procuring abortion, a decoction being administered for this purpose³.

* MORINGA OLEIFERA Lam. (M. PTERYGOSPERMA Gaertn.).

NERIUM INDICUM Mill. (N. ODORUM Soland). English—*Indian oleander, Sweet-scented oleander*; (VERN.—*Karavira, Ganira, Kaner, Khar-sahrah, Sum-el-himar*). It is found in

the Himalayas from Kashmir to Nepal up to an altitude of 6,500 ft. on the Punjab Salt Range extending westwards to Baluchistan, and also in Central India. It is cultivated throughout India in gardens and is apparently wild in south India and in Bombay State along the banks of streams. Roots, bark and seeds contain the active principles neriodorin, neriodorein and karabin (van Rijn¹³), (Bose¹⁴). Several suicidal, homicidal and abortion cases are on record in India from the use of this plant. Commonly used for procuring criminal abortion both by local application and internal administration. In fact the poisonous properties are so well-known in India that it is a proverbial taunt among females to say 'Go and eat the *Kaner* root.'

NIGELLA SATIVA Linn. English—*Small fennel*, *Black cummin*; (VERN.—*Kalajira*, *Kalonji mugrela*). It is cultivated extensively in many parts of India for its seeds which are stated to contain 0.5 to 1.4 per cent. of an essential oil and a saponin-like glycoside, melanthin (Wehmer²). Seeds are used as emmenagogues in Europe; in doses of 10 to 20 grains they have a well-marked emmenagogue action in dysmenorrhoea, and in larger doses produce abortion (Watt³).

* *PEGANUM HARMALA* Linn.

* *PLUMBAGO INDICA* Linn. (P. ROSEA Linn.).

* *PLUMBAGO ZEYLANICA* Linn.

PLUMERIA ACUMINATA Ait. (P. ACUTIFOLIA Poir.). English—*Frangipani*, *Jasmin tree*, *Pagoda tree*; (VERN.—*Arali*, *Champa*, *Gorur-champ*, *Golainchi*, *Gosampige*, *Gulchiu*). It is cultivated as an ornamental tree throughout India and became naturalized in many places. Bark contains a bitter glycoside named plumierid which changes to plumeric acid after treatment with alkaline solutions even in cold (van Rijn¹³). Milky juice contains plumeric acid as a calcium salt (Wehmer²). Root is a violent cathartic and blunt-ended branches are used to procure abortion (Watt³).

* *RANDIA DUMETORUM* Lam.

RUBUS MOLUCCANUS Linn. (VERN.—*Katsol*, *Sufokji*). It is common in many parts of central and eastern tropical and temperate Himalayas from Kumaon to Sikkim at altitudes of 3,000 to 7,000 ft. It occurs also in Assam and in the Khasia Hills at altitudes of 3,000 to 5,000 ft. and in the Ghats from Bombay southwards. According to Rumphius the leaves are abortifacient and have powerful emmenagogue properties (Watt³).

RUTA GRAVEOLENS Linn. var. *ANGUSTIFOLIA* Hook. f.

SALICORNIA BRANCHIATA Roxb. (VERN.—*Medhu*, *Kattumari*, *Umari*). It is found in Gujerat, Kathiawar, Western and Eastern Coast of Madras State, the Sundarbans, etc., on saline marshes or ground covered by the tides. Ash is considered to have emmenagogue and abortifacient properties (Kirtikar and Basu¹⁵).

* *SAPINDUS TRIFOLIATUS* Linn.

* *SEMECARPUS ANACARDIUM* Linn. f.

SESAMUM ORIENTALE Linn. (S. INDICUM Linn.). English—*Gingelly-oil plant*, *Sesame*; (VERN.—*Gingli*, *Kala-til*, *Krishna-til*, *Til*). It is largely cultivated throughout India, being grown as an autumn or even as a winter crop in the warmer parts of the country (the truly tropical areas), and as a summer one in the colder areas. The oil from the seeds contains about 1 per cent. of sesamin and sesamol. The latter breaks up into a phenolic substance sesamol and another substance samin (Andriani¹⁶). Kobert¹⁷ states that the seeds have been used since olden times as emmenagogue and abortive, an opinion which has also been expressed by some writers in India. This view, however, seems to be incorrect judging from the extent to which it is often eaten by Indian women, as for example during the 'bhugga' festival of the Hindus in the Punjab. The existence of any such belief among ladies is unknown.

STACHYTARPHETA JAMAICENSIS (Linn.) Vahl var. *INDICA* H. J. Lam. (S. INDICA Vahl). English—*Aarons rod*; (VERN.—*Jalagali*, *Kariye harni*, *Sinainavirunji*). It is found

practically throughout India from the Punjab and Sylhet to Travancore. It is common as a weed but sometimes it is grown in gardens. It is said to contain a glycosidic substance (Wehmer²). It is not put to any use in India but is stated by Pammel¹⁸ to have abortifacient properties.

* *TAXUS BACCATA* Linn.

* *THEVETIA PERUVIANA* (Pers.) Merr. (*T. NERIIFOLIA* Jues. ex Steud.).

TRIANTHEMA PENTANDRA Linn. (VERN.—*Bishkapra*, *Itsit*). It is a common weed growing on waste lands in the plains of the Punjab, Sind and North-West India. The plant is believed to cause abortion and is apt to produce diarrhoea and paralysis (Stewart¹⁹).

TRIANTHEMA PORTULACASTRUM Linn. (*T. MONOGYNA* Linn.). English—*Horse Purslane*; (VERN.—*Bishkapra*, *Itsit*, *Sabuni*, *Swetpunarna*). It is common throughout India. The present authors have found the presence of water soluble bases and potassium salts in the plant. The roots are stated to have cathartic and irritant properties and are used to procure abortion (Dymock et al¹²).

URENA LOBATA Linn. (VERN.—*Bachita*, *Ban-ochra*, *Vana-bhenda*). It is a common herb, generally distributed throughout the hotter parts of India, very frequently in waste places, and in the bamboo and mango clumps of Bengal. Seeds contain an enzyme urease (Wehmer²). A private communication from Dr. R. C. Muirhead Thomson of the Tocklai Experimental Station, Cinnamara, Upper Assam states that root of this plant are supposed to be widely used for procuring abortion. A short piece of the root is inserted into the vagina and left there for several hours. It is said to be widely used by the Assamese and may possibly be used by the tea garden coolies too.

* *WITHANIA SOMNIFERA* Dun.

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D. INSECTICIDAL AND INSECT-REPELLENT PLANTS

Insects are responsible for incalculable harm to man in many ways. It would be no great exaggeration to say that insects have been directly or indirectly responsible for more loss of life and destruction of property than that caused by wars, floods, earthquakes, fires and famines in the history of man. Advances in civilization are producing conditions suitable for insect multiplication in many places, in spite of all efforts to the contrary. On a moderate computation the annual loss caused to India through insect pest has been put at 2,000 millions of rupees and over a million and a half of human lives. An effective defence against these enemies of social and economic progress will materially reduce this enormous wastage and facilitate national development, in a country like ours. One of the necessities for combating this menace is to find cheap and effective insecticides, commensurate with the means of the great masses in India whose economic condition is very low. For several reasons vegetable insecticides are preferable to the synthetic products, such as arsenicals, copper compounds, D.D.T., B.H.C. (Gammexane), etc. Those from vegetable sources are undoubtedly less deleterious to human beings and other warm-blooded animals generally, and they are also less harmful from the point of view of agriculture. Further, most of the mineral insecticides at the present time are being imported from foreign countries and are therefore expensive. So far as the insecticides from the plant kingdom are concerned, so little is known in the country that we have to depend mostly on those grown in other countries. Some of these such as *Pyrethrum* have been introduced into India and have established themselves fairly well. The larger the number of effective insecticides we discover from among the Indian poisonous plants and the more we encourage the cultivation of well-known insecticidal plants in India, the greater will be the chances of their being brought into extensive use by the people for medical, veterinary, agricultural and household purposes.

Important Insecticidal Plants.—Of the vegetable insecticides of proved value may be mentioned *Chrysanthemum* (pyrethrum), *Derris* (tuba-root), *Lonchocarpus* (cube-root), *Nicotiana* (tobacco), *Tephrosia*, *Picrasma* (quassia), *Delphinium* (larkspur), *Veratrum*, etc. Amongst these, *Chrysanthemum cinerariaefolium* Vis. and *Derris elliptica* (Roxb.) Benth. have acquired great importance as plant insecticides during the last two decades. On account of the effectiveness of the flower-heads of *C. cinerariaefolium* in destroying insects and mosquito larvae, Japan, Kenya and some other countries have taken up the cultivation of this plant and are reaping enormous profits by exporting them to other countries. In India its cultivation has been attempted only very recently and there is every likelihood of this country soon occupying a prominent position amongst the pyrethrum-producing countries of the world. A series of samples analyzed from the material grown in Kashmir, Kangra valley and Mayurbhanj State have given promising results and show it to be as good as any produced elsewhere.

Derris elliptica is found wild to a very limited extent in India. The roots from plants cultivated in Mysore have been found to contain a high percentage of rotenone, one of the important insecticidal constituents occurring in the plant. Several allied species found in India need investigation. Of these *Derris ferruginea* (Roxb.) Benth. has recently been shown to contain rotenone and may prove to be a good insecticide. Tobacco is largely cultivated in India. *Tephrosia vogelli* Hook. f. has been shown in foreign countries to be an efficient insecticide for fleas, lice and ticks, and it has been suggested that it may be used as a cheap commercial dip for cattle. This plant is cultivated in the tea gardens of Assam for use as a green manure, but the leaves examined showed poor insecticidal properties. Some of the other species of *Tephrosia* are also stated to have insecticidal properties but several of the Indian species although met with in abundance, remain uninvestigated. Indian species of *Picrasma* also need investigation, as powdered young leaves and twigs of *P. javanica* Blume var. *nepalensis* (Benn.) Badhwar (syn. *P. nepalensis* Benn.) are used to kill mosquito larvae in Assam. Several Indian species of *Delphinium* are even now used for destroying maggots in wounds and may be potential insecticides. Furthermore, it has been stated that the alkaloid cytisine is an important constituent of the Persian and Australian insect powder. This alkaloid, which resembles nicotine in its action, has been found in at least six genera of which *Euchresta* and *Sophora* are represented in India.

Insect-Repellent Plants.—The importance of insect-repellents in the economy of nations also occupies a prominent place. Here again the cheaper and larger the number of effective insect-repellents that could be used from amongst plants growing in India, the greater the likelihood of the masses of India benefiting from their use. The leaves of neem (*Azadirachta indica* A. Juss.) and of patchouli (*Pogostemon heyneanus* Benth. syn. *P. patchouli* Hook. f. in Fl. Brit. Ind., non Pelletier), and the roots of costus (*Saussurea lappa* C. B. Clarke) are used to protect woollen fabric from insects. Articles placed in boxes made of sandalwood (*Santalum album* Linn.) are immune from the attacks of these pests. Some essential oils, such as the eucalyptus oil from *Eucalyptus globulus* Labill. and citronella oil from *Cymbopogon nardus* (Linn.) Rendle syn. *Andropogon nardus* Linn., when applied to the body, give relief from the bites of mosquitoes so long as the odour lasts. Hemp (*Cannabis sativa* Linn.) if spread under a bedsheet, affords ample protection against the fleas which disturb the sleep at night in many of the hill stations of India. The simple device of mixing the leaves of *Trigonella foenum-graecum* Linn. and of *Vitex negundo* Linn., etc., with the grains before storage, especially in rainy weather, as practised by the agriculturists in some parts of this country, saves the produce from the ravages of insects. Investigation of suitable plants which, when grown, will keep away the mosquitoes from habitations has been engaging the attention of malariologists for some time. No really effective plant for this purpose has so far been discovered, but it may be worthwhile giving extended trials to the shrubby basil (*Ocimum gratissimum* Linn.), absinthe (*Artemisia absinthium* Linn.) and such

other plants which diffuse strong fragrance into the surrounding atmosphere. The use of repellent sprays for protecting cattle from attacks of flies constitutes at the present time an integral part of dairy practice in the progressive countries of the world, although opinion would appear to be still divided as to whether the protection thus afforded results in an actual increase in yield of milk. It is reported that the use of a spray consisting of high-speed Diesel oil, "Pyrocide 20" (a concentrated extract of pyrethrum flowers) and pine oil, when applied on cows for 21 consecutive days proved very effective against some species of biting flies and resulted in an appreciable increase in the yield of milk.

Potentialities in India.—It follows, therefore, that the search of vegetable insecticides and insect-repellent plants from among the vast potential resources existing in this country will repay scrutiny. A list of those reputed is given below. The distribution of such plants in India, their active principles and the manner in which they are used for the purpose in view are briefly mentioned. In addition to plants described, a number of essential oil-bearing plants could be usefully investigated, especially as insect-repellents.

Attention may also be drawn to a recent paper by Hackett and his collaborators³ wherein naturalistic methods in practice for the control of mosquito larvae are discussed. The authors are of the opinion that the method of "herbage-packing" to shallow, small volume running channels is unfavourable to larval growth. It is not every plant, however, that is suitable in the water. According to these authors. "The best so far found in India are *Cleistanthus* species and *Holarrhena antidysenterica*". There is no doubt that a number of plants mentioned below as also many others amongst the Indian poisonous plants dealt with by Chopra and Badhwar¹ would be found to be equally good or even better for this purpose

Important Indian Insecticides of Vegetable Origin

1. **Pyrethrum.**—Principal among these is pyrethrum derived from a plant belonging to the genus *Chrysanthemum* of the family Compositae. Pyrethrum flowers are somewhat similar to the common daisy. It is grown chiefly in Japan, Dalmatia, Yugoslavia, Italy, Kenya and other countries round the Mediterranean sea.

The flower heads of the following species are known to be toxic to insects : (a) *C. roseum* (b) *C. carcum* and (c) *C. cinerariaefolium*. The last species possesses high insecticidal properties and larger yield of flowers and is, therefore, cultivated widely. Commerce in these flowers originated in certain provinces of Persia and Dalmatia under the various names of Persian powder, Dalmatian powder, as simply 'Insect powder' and more recently 'Jose sticks' from Japan. Pyrethrum has been successfully cultivated in India (Kashmir and Nilgiris) and approximately 500 tons per annum is produced in the country.

CHEMISTRY.—Although all parts of the plant are more or less toxic to insects, most of the toxic principles are contained in the flower head. LaForge and his associates have demonstrated that the natural active principles of pyrethrum flowers

are the four esters namely, Pyrethrins (I and II) and Cinerins (I and II). These are formed from chrysanthemum monocarboxylic and chrysanthemum dicarboxylic acids, and the alcohols pyrethrolone and cinerolone. Allyl homologue of cinerin I, has been successfully synthesized in the laboratory and the so-called synthetic pyrethrum may be commercially available in due course. These esters are highly complex in composition. They are particularly insoluble in water but dissolve readily in most of the organic solvents such as alcohol, acetone, ether and kerosene. The total pyrethrin contents of the dried flowers vary from 0.3 to 1.2 per cent., depending on the altitude where it is cultivated, the season, the nature of the soil, climatic conditions and other factors. On greater quantity of the active principles of the flowers will depend the higher degree of toxicity to insects. Extracts are usually prepared from flowers with the highest pyrethrin contents.

Pyrethrum should be coarsely ground for extraction with kerosene or any other solvent. Most of the Pyrethrum sprays are extracts in kerosene oil or some other mineral oil resembling kerosene. Two per cent., 4 per cent. and 10 per cent. concentrated extracts are commercially available. For spraying purposes, the extract is diluted so as to contain approximately 0.1 per cent. pyrethrins. The expense on sprays can be reduced by using pyrethrum emulsions instead of the usual pyrethrum kerosene solution. An oil-soap emulsion may be made as follows: Two parts (by volume) of pyrethrum extract are mixed with 2 parts of groundnut oil (it is possible that other vegetable oils would be equally suitable). The mixture is gradually added to one part of 20 per cent. soap solution (prepared by adding 2½ lb. neutral soap, without any free alkali to 1 gallon of water), thoroughly agitating all the time to produce a uniform stock emulsion. This emulsion concentrate retains its full efficacy for about two months after which, it gradually deteriorates. The spray prepared with water loses about 50 per cent. of its potency in 24 hours and should therefore be prepared daily. A number of emulsifiers have been developed which prevent deterioration of the pyrethrins.

The pyrethrins are contact poisons and paralyse the central nervous system of the insects. They have a quick knock-down effect in contrast to the slow action of other recent synthetic organic insecticides. Pyrethrum sprays have been successfully used for the control of malaria. The rationale of this method is that mosquito after taking an effective blood feed is able to transmit malaria only after 10-12 days and if the mosquito could be destroyed within this period, transmission of malaria would not be possible. After taking the blood feed at night, the mosquito rests in dark rooms, cattle-sheds, etc. and spray killing is done by finely atomising the insecticides in these rooms. The efficacy of this method is therefore directly proportionate to the frequency with which spraying is carried out, when the vector species passes most of its day inside rooms and cattle sheds and the infection rate among the mosquitoes is also low; good results are obtained by spraying once a week. In highly malarious areas, however, where the infection rate among the local mosquitoes is high, and the mosquitoes often rest during the day outside houses and cattle sheds, it is necessary to spray twice or thrice a week; and during an epidemic as often as possible.

All the human dwellings and cattle sheds within a distance of half a mile of the community to be protected should be sprayed. As far as possible, every opening into the room should be closed at the time of spraying and should remain closed for 20 minutes thereafter. The spray is generally directed upwards and in a closed room $\frac{1}{2}$ oz. of spray solution is sufficient for one thousand cu. ft. space. But when spraying in structures which cannot be completely closed, double the quantity should be used. For small rooms, hand operated atomisers of various types are used but electric or petrol power driven portable spray machines have been found more suitable for large barracks and buildings. Pyrethrum extract may also be applied in the form of a very finely atomized aerosol dispersed by special aerosol bombs. These dispersers are of various sizes and the atomization is achieved either by freon, carbon dioxide or arcton gas. The bombs are useful for the disinfection of aircraft, tents and railway compartments, etc. Pyrethrum sprays are not toxic to man and livestock and can be used without any elaborate precautions. A slight fire danger may exist in the use of kerosene sprays but in practice no such disaster has been reported. Pyrethrum sprays have been successfully employed for the control of most of the other insects affecting man and spraying technique is the same discussed above.

SYNERGISTS FOR PYRETHRUM.—The scarcity of pyrethrum during World War II stimulated research on methods of extending available stocks resulting in the development of a number of activators or 'synergists', which by themselves have little or no value as insecticides. Their addition materially increases efficacy of pyrethrum. Sesame oil, piperonyl cyclohexanone and piperonyl butoxide have been reported as satisfactory synergists. Certain components of pine oil particularly glycol ether of pinine have been used in fly sprays. Similarly N-Iso butyl undecyleneamide has been found to increase the toxicity of pyrethrins. Other similar compounds are: N-Iso butyl piperonylamide, N-butyl piperonlamide, and N, N-diethyl piperonylamide.

Combination of pyrethrum and DDT or other organic insecticides is used in order to obtain a quick knock-down and lethal effect and long residual effect. The formulation contains 3 oz. of 1 per cent. pyrethrum extract, 0.5 oz. of DDT in 97 oz. of kerosene giving a concentration of 0.03 per cent. pyrethrins and 0.5 per cent. DDT in the spray.

2. **Nicotine ($C_{10}H_{14}N_2$).**—It is the principal alkaloid found in tobacco plant, which in its pure form is an almost colourless and odourless oily liquid of 1,0093 API density and boiling point of 246°C . It is readily soluble in water and to a lesser extent in mineral oil fractions. The alkaloid is present in all parts of the tobacco plant varying in amounts from a fraction of 1 per cent. to 4 or 5 per cent. Commercial preparations are commonly marketed as nicotine sulphate. The sulphate form is non-volatile and is less toxic than the alkaloid itself. It is, therefore, safer to handle. Alkaline water is used as a carrier for the nicotine sprays in order to neutralize the free acid. Oil sprays of nicotine or emulsions are also used. The principal use of nicotine is against agricultural pests and it may be used in combination with pyrethrum sprays in the public health field.

3. **Rotenone and Rotenoids.**—These are active toxic principles of the Derris plant. Derris grows principally in the Far East. Eighty or more species are known but only two, *Derris elliptica* and *Derris malaccensis* from Malaya are cultivated. The roots are dug up when the plant is about two years old at a time of the year when the Rotenone ($C_{23}H_{22}O_6$) content is highest. Rotenone is a white crystalline substance with a melting point of $163^{\circ}C$. Crystalline Rotenone is stable but in certain organic solvents breaks down after a varying length of time, particularly on exposure to sunlight and ultra-violet radiation. Rotenone and its related compounds act as both contact and stomach poisons but not as fumigants. Applications are made as dusts, sprays, aerosols, etc. Dust mixtures are compounded with an inert base as in the case of Paris green. Liquid sprays may be prepared by making suspension of the powdered roots or by making an aqueous extract or as a colloidal suspension. Rotenone and Rotenoides were used to supplement the limited supply of Nicotine and Pyrethrum. The former is effective against fleas, lice, flies and a number of insect larvae. With the discovery of DDT and other synthetic organic insecticides, however, the rotenones have been replaced and their use in the public health field is very restricted.

4. **Synthetic Insecticides.**—Inorganic chemicals, such as arsenic and sulphur, were used for insecticidal purposes for quite a long time and practically no attention was given to the organic compounds. But gradually, as pyrethrum and nicotine sprays were developed, the chemists started to synthesise organic compounds. As a result, DDT and a host of other chemicals have now been discovered. In contrast to the inorganic insecticides, organic compounds have proved effective, and some possess the added advantage of being toxic for a number of days, weeks, or even months after application on insect resting places. This residual toxicity of synthetic insecticides when applied to insect resting places, is the most significant property that marks them out as unique insecticides. But most of these organic compounds, including DDT are by no means toxic to all insects. Experience has shown that they are decidedly valuable for the control of certain types of insects, while ineffective against others.

Below is given the list of plants occurring in India which have been reported to possess insecticidal, insect-repellent and piscicidal properties.

Insecticidal and Insect-repellent Plants

[* For detailed description refer to Parts II and III]

*** ACORUS CALAMUS Linn.**

ACORUS GRAMINEUS Soland. A semi-aquatic herb found in the Khasia Hills and Sikkim Himalayas at altitudes of 4,000 to 6,000 ft. It contains an essential oil. The root-stock is used in China as an insectifuge and insecticide (⁷⁸).

ADINA CORDIFOLIA (Roxb.) Benth. & Hook. f. (S.—*Dharakadambu*; H.—*Haldu*; B.—*Keli kadam*; M.—*Manja kadamba*). A large deciduous tree found in sub-Himalayan tract from the Jumna eastwards, ascending to 3,000 ft. and extending throughout the moister regions of India. It is common in western India, especially in the forests of Surat, Ratnagiri and Thana districts; also plentiful in Mysore, Upper Godaveri and Bhandara. It contains bitter principle. Its juice is employed to kill maggots in sores (¹⁰).

- AGAVE AMERICANA Linn. (H.—*Kantala*; B.—*Jungli anarash*). A stout shrubby plant with a rosette of spiny leaves. A native of America planted in parks and gardens throughout India. Its leaves contain an acrid volatile oil and the roots contain a crystalline saponin. Leaves likely to contain saponins. Wall paper impregnated with juice of the leaves is said to be proof against the ravages of white ants (^{9 11 12 13}).
- ANACARDIUM OCCIDENTALE Linn. (H. & Bo.—*Kaju*; B.—*Hijli badam*; M.—*Mundiri-kai*). A small tree from South America, now established in the coastal districts of south India, Chittagong and the Andaman Islands. From it may be extracted a black, caustic, oily juice containing phenolic compound cardol, anacardic acid and an ether-soluble substance. Its juice is used to protect timber, books, etc. from white ants (¹⁴).
- ANAMIRTA COCCULUS (Linn.) W. & A. (Bo.—*Kakaphala*; H. & S.—*Kakmari*; M.—*Kakkay-kolli-virai*). A large climbing shrub found in Assam, Eastern Bengal, Oudh Orissa and Konkan southwards to Ceylon. Its seeds contain picrotoxin. A kind of ointment prepared from the drupes is employed as an insecticide (¹²).
- ANDRACHNE CORDIFOLIA Muell.-Arg. (P.—*Gurguli*). An erect shrub met within the temperate Himalayas from the Indus eastwards to Nepal at altitudes of 4,000 to 8,000 ft. common in shady places. The leaves contain hydrocyanic acid. The leaves are believed by people in Jammu to have insecticidal properties. The powdered root-bark of *A. ovalis* Muell.-Arg. of Africa is used as a fly exterminator by the Zulus, after it is mixed with milk (^{9 11}).
- ANNONA RETICULATA Linn. (H.—*Louna*; P.—*Nona*; Bo.—*Ramphal*; M.—*Ramsita*). A small American tree, cultivated, but not so extensively as *A. squamosa*. The bark contains an alkaloid anonaine. The properties are similar to *A. squamosa* (¹⁵).
- ANNONA SQUAMOSA Linn. (S.—*Gandhagatra*; H.—*Sitaphal*; B.—*Ata*; M.—*Sitaphalam*). An American tree about 20 ft. high. Cultivated and naturalized in several parts of India. The seeds contain an oil and a resin which contains an acrid principle and the leaves and seeds contain an amorphous alkaloid. The seeds, leaves and the immature fruit contain an acrid principle fatal to insects; the dried unripe fruit, powdered and mixed with gram flour is used for killing vermin and the seeds to kill body lice. The powdered seeds and an aqueous infusion of the leaves is believed to possess valuable insecticidal properties (^{9 13 16 17}).
- ARISAEMA SPECIOSUM (Wall.) Mart. (P.—*Kiralu*). A tall tuberous herb occurring in the temperate Himalayas from Hazara to Sikkim and Bhutan at altitudes of 7,000 to 10,000 ft. It yields an acrid juice. The properties are similar to *A. tortuosum*.
- ARISAEMA TORTUOSUM (Wall.) Schott. (P.—*Samp-ki-kumb*). A tall tuberous herb found in the temperate and sub-tropical Himalayas from Simla to Bhutan at altitudes of about 8,000 ft.; also in Khasia Hills, Manipur, Chota Nagpur, Ranchi and Parasnath. In western India it is met with in Konkan; in Madras State in Rampa Hills at altitudes of 4,500 ft., Horsleykonda at 4,000 ft., and in Western Ghats at 3,000 to 4,000 ft. It yields an acrid juice. The tubers are used to kill worms which infest cattle during the rainy season. A decoction from the tubers prepared from some other species belonging to *Arisaema* also used to kill insects in India and abroad.
- ARISTOLOCHIA BRACTEATA Retz. (S.—*Dhumrapatra*; H.—*Kiramar*; M.—*Aauthina-palai*). A slender prostrate herb grows on the banks of the Jumna and the Ganges, and in Bundelkhand, Sind and Konkan. In the Madras Presidency it is found in the Northern Circars, the Deccan and Carnatic, on dry soil especially the black cotton soil. Its occurrence in Bihar is doubtful. It yields a nauseous volatile substance and an alkaloid. The juice is applied to foul and neglected ulcers to destroy insect larvae. The vernacular name 'kirimar' (insect killer) is expressive of this fact (¹⁸).

* ARTEMISIA ABSINTHIUM Linn.

* AZADIRACHTA INDICA A. Juss.

BAMBUSA ARUNDINACEA Willd. (S.—*Vansa*; B. & H.—*Bans*; Bo.—*Mandgay*; M.—*Mungil*).

It is a common bamboo in central and south India, cultivated in many places in north-west India and in Bengal. It contains benzoic acid and traces of a cyanogenetic glycoside in shoots. The shoots have lethal action on mosquito larvae⁽²⁵⁾.

* **BUTEA MONOSPERMA** (Lam.) Kuntze.

CALONYCTION MURICATUM (Linn.) G. Don syn. *Ipomoea muricata* Jacq. It is a large twiner found in the Himalayas from Kangra to Sikkim up to an altitude of 5,000 ft. and also in the upper Gangetic Plain, Bengal and the Deccan Hills; often cultivated for the sake of its thickened pedicels which are edible. The seeds contain a resin. The juice of the plant is used to destroy bugs^(11, 13).

* **CANNABIS SATIVA** Linn.

CASSYTHA FILIFORMIS Linn. (S.—*Akashavalli*; H.—*Amarbeli*; B.—*Akasbel*). It is a wiry leafless twining parasite throughout the greater part of India, especially near the sea coast. It contains an alkaloid. According to Pappe, quoted by Watt and Breyer Brandwijk, it has been used as a wash for scalp and head and for the destruction of vermin^(11, 13).

* **CENTRATHERUM ANTHELMINTICUM** (Willd.) Kuntze. syn. *Vernonia anthelmintica* (Willd.).

* **CHRYSANTHEMUM CINERARIAEFOLIUM** Vis.

CIMICIFUGA FOETIDA Linn. (P.—*Jiunti*). It is a tall robust perennial found in the Himalayas from Kashmir to Bhutan at altitudes of 7,000 to 12,000 ft. The rhizomes of *C. racemosa* (Linn.) Nuttall a foreign species contain a saponin, a glycosidic tannin, a water soluble glycoside, and a glycoside insoluble in water but soluble in alcohol. These also contain an essential oil. It is possible that the Indian plant contains identical or similar constituents. The roots are used to drive away bugs and fleas in Siberia; the flowers and unripe fruits have an extremely foetid smell and probably have the same property, hence its English name, bugbane⁽³⁵⁾.

* **CINNAMOMUM CAMPHORA** Nees & Ebern.

CROTON OBLONGIFOLIUS Roxb. (B.—*Baragach*; H.—*Chucka*; Bo.—*Ganasur*; M.—*Bhutan-kusamu*). It is a small deciduous tree found in the sub-Himalayan tract from Oudh eastwards; also in Bengal, Sylhet, Chota Nagpur, and in central, western and southern India. The seeds contain an oil with properties similar to that of *C. tiglium*.

CROTON TIGLIUM Linn. (S.—*Jayaphala*; H.—*Jamalgota*; B.—*Joypal*; Bo.—*Geyapal*; M.—*Nervalam*). It is a small evergreen tree planted in gardens more or less throughout India; almost becoming naturalized in Bengal and Assam. The seeds contain an oil which is the most violent of all cathartics. They also contain an alkaloid ricinine, and two toxic proteins. The oil is sometimes used as an insecticide^(9, 13).

CUCUMIS SATIVUS Linn. (Wild form). (S.—*Sukasa*; H.—*Khira*; B.—*Sasa*; Bo.—*Kankri*; M.—*Mulluvellari*). A hispidly hairy climber cultivated in all warm and warm temperate countries; also found wild in northern India. The fruits contain a proteolytic enzyme resembling erepsin. It contains also a bitter substance the nature of which has not been ascertained. It has been said that the juice banished wood lice and fish insects and freshly cut slices are strewn in their haunts for this purpose⁽³⁸⁾.

* **CURCUMA LONGA** Roxb.

CYMBOPOGON NARDUS (Linn.) Rendle syn. *Andropogon nardus* Linn. It is a tall aromatic grass cultivated for the sake of its aromatic oil. According to some authors, this plant is also found wild in India. The essential oil known as oil of citronella is obtained from leaves. The commercial supply of oil of citronella is obtained principally from Ceylon, Burma and the Straits Settlements. It is an important constituent of mosquito repellent preparations found in the market.

CYNANCHUM ARNOTTIANUM Wight. It is an erect plant found in Kashmir at altitudes of 6,000 to 8,000 ft., also in Baluchistan. The leaves are dried and powdered and used to destroy maggots which infest wounds in animals.

DELPHINIUM BRUNONIANUM Royle. (P.—*Laskar*). It is an erect simple herb found in the western Himalayas and Tibet at altitudes of between 13,000 and 17,000 ft. Aitchison remarks that the juice of the leaves is used in Kurrum (Pakistan) to destroy ticks on animals, particularly when they affect sheep⁽⁸⁹⁾.

DELPHINIUM CAERULEUM Jacq. ex Camb. (P.—*Dhakangu*). It is an erect herb met with on the Alpine Himalayas from Kumaon to Sikkim; it is common in the Sulej basin at altitudes of 8,000 to 17,000 ft. The root is applied to kill maggots in the wounds of goats⁽¹³⁾.

DELPHINIUM ELATUM Linn. It is a sparingly branched herb found in the west temperate Himalayas from Kashmir to Kumaon and in the inner Tibetan valleys at altitudes of 10,000 to 12,000 ft. It contains alkaloids. In Europe the seeds are used as an insecticide^(13' 40).

DERRIS ELLIPTICA (Roxb.) Benth. (Mal.—*Tubah*).

DURANTA REPENS: Linn. syn. *D. Plumieri* Jacq. It is an evergreen shrub, one of the commonest hedge plants in Indian gardens. The leaves contain a saponin. The berries contain an alkaloid analogous to narcotine. When macerated, the berries exude a juice which is lethal to all anophelines and culicines. Manson has found that the juice is lethal to anophelines and culicines in dilutions of 1 in 100. The action on culicines is less marked than on anophelines^(9' 102' 103).

* **EUCALYPTUS GLOBULUS** Labill.

EUPHORBIA ANTIQUORUM Linn.

EUPHORBIA THYMIFOLIA Linn. (S.—*Racta-vinda-chada*; H.—*Chhoti dudhi*; B.—*Dudiya*; Bo.—*Nayeti*; M.—*Sittrapaladi*). It is a small prostrate annual found throughout greater part of India, up to an altitude of 4,000 ft. on the Himalayas. It contains an essential oil which is used in sprays to keep off flies and mosquitoes from inhabited rooms⁽⁵³⁾.

GARDENIA CAMPANULATA Roxb. (Burm.—*Hsaythanpaya*). It is a shrub found at the foot of the Sikkim Himalayas, Assam, Sylhet, Chittagong and at the summit of Parasnath Hill in Bihar. It contains a saponin. The fruit is used as a fish poison and the fruit juice is an efficient larvicide in dilutions up to 1 in 80⁽¹²⁰⁾.

GAULTHERIA FRAGRANTISSIMA Wall. It is a stout herb met with from Nepal to Bhutan at 6,000 to 8,000 ft.; also on the Khasia Hills, Western Ghats, the Nilgiris, the Pulneys and Hills of Travancore at altitudes over 5,000 ft. It contains an essential oil in the leaves and other parts of the plant. The essential oil is a constituent of several insecticidal and insect-repellent preparations^(10' 54).

GLORIOSA SUPERBA Linn. (S.—*Shakra pushpi*; H.—*Kalihari*; B.—*Bishlanguli*; Bo.—*Karia-nag*; M.—*Agnisikha*). It is a tall herbaceous climber found throughout tropical India up to 7,000 ft. on the hills; common in Mysore State. The rootstock contains a toxic bitter principle, alkaloid colchicine and two other bases. The juice of the leaves is used to destroy lice in the hair^(8' 55' 56).

GYNANDROPSIS GYNANDRA (Linn.) Merr. syn. *G. pentaphylla* DC. (S.—*Surjavarta*; H.—*Karalia*; B.—*Hurhuria*; Bo.—*Tilavana*; M.—*Taivela*). It is a strong smelling, somewhat foetid herb, abundant throughout the warmer parts of India. It contains an acrid volatile oil. The seeds, rubbed with oil, are used to destroy head lice⁽¹⁸⁾.

HEDERA HELIX Linn.

KALANCHOE SPATHULATA (Poir) DC. (H.—*Tatara*). A succulent perennial found in the tropical and sub-tropical Himalayas from Kashmir to Bhutan generally at altitude between 1,000 to 4,000 ft.; near Simla it ascends to 6,000 ft. above the sea level. The leaves are stated to be poisonous to insects.

LAGENANDRA TOXICARIA Dalz. (Bo.—*Rukh-alu*; M.—*Maravara tsjembu*). It is a herb found in marshes and along water courses, often growing gregariously in Konkan, Southern Maharatta Country, North Kanara Mysore, Coorg and throughout the West Coast and Ghats of the Madras state up to an altitude of 4,000 ft. It contains an acrid juice. The plant is said to have insecticidal properties⁽⁸⁾.

* MADHUCA LATIFOLIA (Roxb.) Macbride syn. *Bassia latifolia* Roxb.

* MADHUCA LONGIFOLIA (Linn.) Macbride syn. *Bassia longifolia* Linn. (S.—*Madhuka*; H.—*Mohua*; B.—*Mohuva*; Bo.—*Mahwa*; M.—*Illupai*). It is a large tree found in the forests of western India from Konkan southwards to Travancore; it is common in Malabar, Mysore, Anamalais and the Circars at low elevations. After extraction of the oil from seeds, a sapo-glycoside called mowrin is obtained from the residue. The residual cake, 'mowrah meal', after the extraction of the oil from the seeds, is used as a worm killer for lawns as in the case of *M. latifolia*. It is also used as a fish poison⁽⁴¹⁾.

MELALEUCA LEUCADENDRON Linn. (H., B. & Bo.—*Kayaputi*; M.—*Kaiyappudai*). It is an evergreen tree found in the Tenasserim, Mergui, Malacca, Malaya Islands and Australia, var. *leucadendron* Duthie is cultivated in India. The essential oil, known as cajuput oil, is distilled from the leaves and twigs. Cajuput oil is an excellent mosquito repellent and has the advantage over oil of citronella in that it volatilizes more slowly.

MILLETTIA AURICULATA Baker ex Brand. It is large robust woody climber common in the outer Himalayas from Sutlej eastwards to Sikkim upto an altitude of 3,500 ft. It is abundant in the forest tracts of Dehra Dun, the Siwalik Range, Rohilkhand, North Oudh, Gorakhpur and Bundelkhand; also in Bihar, Orissa and Bengal and in the forests of Ganjam and Vizagapatam upto 4,000 ft. The powdered root is applied to sores in cattle to kill vermin⁽¹³⁾.

NICANDRA PHYSALOIDES Gaertn. It is an erect annual herb introduced from Peru, but now found as a weed on rich soils in many parts of India up to an altitude of 7,000 ft., on the Himalayas; it is often grown in gardens. In Madagascar, a decoction of the leaf is stated to be used to destroy head lice. It is also stated to be used as a fly poison in parts of the United States of America^(8'9).

NICOTIANA RUSTICA Linn. (H. & B.—*Vilayati tamaku*; P.—*Kakkar tamaku*). It is an erect herb cultivated in the Western Punjab, Balluchistan, Bengal and other places in India, but sparingly as compared with *N. tabacum*. The properties are similar to *N. tabacum*.

NICOTIANA TABACUM Linn. (H.—*Tamaku*; B.—*Tamak*; Bo.—*Tambaku*; M.—*Pugaiyilay*). It is an erect herb cultivated throughout India; sometimes met with as an escape. Its leaves, stems and roots contain a volatile alkaloïd, nicotine and the leaves also contain several other alkaloids and two glycosides. Preparations from the leaves and crude solutions of nicotine are extensively employed as insecticides in horticulture by dusting or spraying or by vaporization. Similar preparations are sometimes used as external application and as parasiticides in veterinary practice. Tobacco leaves are also used to ward off leeches, for which purpose they are placed under the stockings during marches in damp forest localities that are infested with these pests.

* NIGELLA SATIVA Linn. (H. & B.—*Kalajira*; *Vridhatulasi*; Bo.—*Kalenjire*).

OCIMUM GRATISSIMUM Linn. (S.—*Vantulshi*; H. & B.—*Ramtulshi*; Bo.—*Ramatulasa*; M.—*Blumichcham-tulasi*). It is cultivated in gardens throughout Bengal, East Nepal and the Deccan Peninsula; it is said to be a common wild plant in Western India. It contains an essential oil, thymol, eugenol and methyl chavicol. The shrubby basil is popularly believed to be a good mosquito repellent and its plantation has been suggested as a measure of biological control of mosquitoes. It diffuses a strong fragrance than any other member of the genus *ocimum*. In this connection it may be remarked that *O. sanctum* Linn. is also believed to have similar properties⁽¹⁰⁾.

PACHYGONE OVATA (Poir.) Miers ex Hook. f. & Thoms. It is a lofty climber found in the sandy sea shores of the Coromandel Coast from Nellore to Tanjore and Tinnevely; also in the Deccan in Bellary, Cuddapah and Mysore. The dried fruit is used for the purpose of destroying vermin (^{81 82}).

* *PEGANUM HARMALA* Linn.

PICRAMNA JAVANICA Blume. var. *nepalensis* (Benn.) Badhwar (syn. *P. nepalensis* Benn.). It is a moderate-sized tree found in Assam and Nepal. The powdered young leaves and the twigs of this plant are used as larvicide in Assam.

PIERIS OVALIFOLIA D. Don. It is a small deciduous tree found in the outer Himalayas from the Indus eastwards, usually from 3,000 to 8,000 ft. above sea level, common east of the Ravi (Punjab) and in the Khasia Hills between 3,000 to 5,000 ft. It contains a toxic substance, and rosmadotoxin. The young leaves are believed by people in Jammu Kashmir to have insecticidal properties(⁷²).

POGOSTEMON HEYNEANUS Benth. syn. *P. patchouli* Hook. f. (Fl. Brit. Ind., non Pelletier). (H.—*Pacholi*; B.—*Pachapat*; Bo.—*Patch pan*). It is a strongly aromatic herb found in Western Ghats from South Kanara southwards in open forest land; often cultivated and then run wild. Also about Kotagiri in the Nilgiris at 6,000 ft. Sometimes cultivated in gardens in Bombay and Bengal. It contains an essential oil. The dried leaves are extensively employed for scenting clothes to keep off insects from shawls, etc.

POLYGONUM FLACCIDUM Meissn. It occurs throughout India; in the Himalayas to altitude of 4,000 ft. It is locally used in Assam as a germicide and as a fish poison. The greenish mucilaginous juice of the plant kills off mosquito larvae in 15 minutes, but is not lethal in dilution(¹⁰²).

POLYGONUM HYDROPIPER Linn.

RANDIA DUMETORUM Lam.

* *RICINUS COMMUNIS* Linn.

* *RUTA GRAVEOLENS* Linn.

* *SANTALUM ALBUM* Linn.

SARCOSTEMMA ACIDUM (Roxb.) Voigt. syn. *S. brevistigma* W. & A. (S. & Bo.—*Soma*; H. & B.—*Somlatu*; M.—*Kondapala*). It is a leafless, trailing or twining, jointed shrub usually found on acrid rocks in Konkan, the Deccan, Northern Circars, Carnatic and on Horsleykonda up to an altitude of 4,500 ft.; Singbhum and Puri; also reported from Ranchi; it occurs in Bengal also. It is often used by farmers to extirpate white ants from sugarcane fields. A bundle of twigs is put into the trough of the well from which the field is watered, along with a bag of salt hard packed, so that it may dissolve gradually. The water so impregnated has been stated to destroy ants without injuring the crop. Three other Indian species of this genus which are almost indistinguishable in a dry state from this plant are similarly used. Two of them, viz., *S. brunonianum* Wight and Arn. and *S. intermedium* Decne. are inhabitants of the western and southern India. The third *S. stocksii* Hook. f., is found in Sind and Southern Maharatta country, and is more robust than any of the other three. These are known by the same vernacular names as *S. acidum*.

* *SAUSSUREA LAPPA* C.B. Clarke.

SCHLEICHERA OLEOSA (Lour.) Merr. syn. *S. trijuga* Willd. (H.—*Kosum*; Bo.—*Kosam*; M.—*Pu-maram*). It is a large tree found in dry forests of the sub-Himalayan tracts, from the Sutlej eastwards and throughout central and southern India. The seeds contain a fixed oil and small quantities of a cyanogenetic compound. The powdered seeds are applied to ulcers in animals for removing maggots (^{82 83}).

SCLERIA PERGRACILIS (Nees) Kunth. It is widely scattered from Garhwal at an altitude of 5,000 ft. to Assam, Bihar, Chota Nagpur and the Deccan. The lemon-scented leaves are used to drive away mosquitoes(⁸⁴).

SOPHORA MOLLIS R. Grah. It is a low shrub found in the Himalayas and sub-Himalayan tracts of north-western India from Gilgit, Chitral, Hazara and the salt Range to Kumaon and Nepal up to an altitude of 7,00 ft. It is also locally common near Malakand, in Kagan and Kilba Bushahr, and Sahansradhara near Dehra Dun. It contains an alkaloid, sophorine, which is identical with cytisine has been isolated from *S. tomentosa* Linn. found in the Andaman and Nicobar Islands and also occasionally cultivated in Indian gardens. This alkaloid has insecticidal properties although the use of the plant as an insecticide is not recorded. It is likely that *S. mollis* contains similar or identical alkaloid. The seeds are stated to be useful for destroying vermin (⁸).

TEPHROSIA VOGELII Hook. f. It is cultivated in Assam by tea planters as a green manure. Its leaves contain tephrosin and deguelin and seeds contain tephrosin, deguelin, dehydrodeguelin, allotephrosin and isodeguelin. The leaves are said to be an efficient insecticide against fleas. In fact, it has been suggested that the plant might be used as commercial dip for cattle. The present authors have recently examined the leaves of the Assam grown plant. They do not possess insecticidal properties to any marked degree. It is possible, however, that this conclusion may have to be modified when leaves plucked at various times of the year are examined. Its seeds, which are stated to be the most toxic part of the plant, have not been examined so far. About a dozen species of *Tephrosia* are found in India and some of them are commonly met with. Two of them viz., *T. Candida* (Roxb.) DC. and *T. purpurea* (Linn.) Pers., are reported to be used as fish poison. It is likely that some of the Indian plants may also have valuable insecticidal properties (¹¹ ⁹⁴ ⁹⁵ ⁹⁶).

TRIGONELLA FOENUM-GRÆCUM Linn. (H., B., & Bo.—*Methi*; M.—*Vendayam*). It is an aromatic annual herb found wild in Kashmir, the Punjab and the Upper Gangestic plain and it is widely cultivated in many parts of India. It contains an alkaloid trigonelline and an essential oil. Fenugreek is used as an insect repellent. The agriculturists in the Kangra district in the Punjab mix the dried plant with their grains stored up in bags, in order to protect them from attacks of insects during rainy weather (¹⁰).

* **VITEX NEGUNDO** Linn.

ZANTHOXYLUM HAMILTONIANUM Wall. (Nep.—*Purpuray timur*.) It is a climbing thorny shrub of Sikkim and Assam. The roots are used as fish poison. A boiled fresh solution of the roots killed 100 anopheline larvae in 7 minutes. It acts equally on anophelines and culicines but has no action on pupae. The diluted juice loses its potency after 3 days and becomes inert on the fifth day (¹⁰²).

E. REPUTED PISCICIDAL PLANTS

There is a group of plants which are closely allied to insecticidal and insect-repellent plants, which are poisonous to fishes and have been used by people to procure fish for food from streams and ponds. Some of the piscicides have also insecticidal properties and *vice versa*. It is possible that systematic investigation of plants poisonous to fishes may lead to the discovery of effective insecticides. The list of plants growing in India which are alleged to have poisonous action on fishes is very long and a large number of them have been referred to the 'Glossary of Indian Medicinal Plants' (1956). Many of these plants contain saponins and other principles such as alkaloids, glycosides, essential oils, etc. which act by paralysing either the nervous system of gills or by directly acting on their musculature. The knowledge with regard to this group of plants has been chiefly gathered from the people living in areas in forests along the course of rivers or banks of lakes.

Below is given a list of plants which are believed to be poisonous to fish. No systematic work has so far been done on these plants and these are, therefore, an unexplored field.

Reputed Piscicidal Plants

[* For detailed description refer to Parts II and III]

ACACIA FENNATA (Linn.) Willd. It is a large scrambling or climbing shrub found in the central and eastern Himalayas up to an altitude of 5,000 ft., also in Oudh, Bengal, Bihar and in central, western and south India; it is also reported from the north-west Himalayas. The fruit and stem are used in Burma to poison fish.

ACRONYCHIA PEDUNCULATA (Linn.) Miq. (syn. *A. laurifolia* Blume). It is a small tree found in Dehra Dun, Konkan, North Kanara, the hill forests of the Western Ghats of Madras State up to an altitude of 6,000 ft., South Deccan, Northern Circars, Orissa. Sikkim upto 3,000 to 4,000 ft., Khasia Hills upto 4,000 ft., Assam and Chittagong. Pammel reports it to be a fish poison ⁽⁸⁾.

ALBLIZZIA CHINENSIS (Osbeck) Merr. syn. *A. stipulata* Boivin. It is a large tree found throughout India, ascending to an altitude of 4,000 ft. in the Himalayas. It contains a saponin. Pammel records it as a fish poison ^(9 12).

ALBIZZIA PROCERA (Roxb.) Benth. It is a tall tree found in the sub-Himalayan tracts from the Jumna eastwards; also in Bengal, Bihar, Orissa, Madhya Pradesh, Bombay State and south India, usually in moist places. Occasionally planted as ornamentals or roadside tree. The bark of this tree when pounded and thrown into a pond is believed to stupefy fish. Kirtikar and Basu mention that the leaves have insecticidal properties ^(8 13).

ANAGALLIS ARVENSIS Linn. It is an erect or procumbent annual found over the greater part of India upto an altitude of 8,000 ft. in the Himalayas. The red-flowered variety is found in Kashmir, but the blue-flowered one is more common in India. The volatile oil and two glycosidic saponins have been isolated from the herb, while the root contains cyclamin which is also a glycosidic saponin. It is used in India to intoxicate fish and to expel leeches from the nostrils of livestock ^(9 12).

APAMA TOMENTOSA Engl. syn. *Bragantia tomentosa* Blume. It is a herbaceous plant found in Assam and Manipur. It is regarded as a fish poison ⁽⁹⁾.

ARENCA OBTUSIFOLIA Mart. It is a Malayan palm found in India only under cultivation. In the Philippine Islands it is used for poisoning fishes (⁸).

ASCLEPIAS CURASSAVICA Linn. The plant is a native of the West Indies ; often grown in gardens and has become naturalized in many parts of India. The herb contains the glycoside asclepiadin. The roots contain vincetoxin which closely resemble emetine in its physiological action. It is used to procure fish in the West Indies and in Queensland (¹⁸ ²⁰ ²¹ ²²).

BALANITES ROXBURGHII Planch. It is a shrub or small evergreen tree found in the drier parts of India extending from south-east Punjab and Delhi to Sikkim, Bengal, Central India, Bombay State and South India. The flesh of the fruit contains about 7.2 per cent. of saponins. The bark is used in several places in India and by African Arabs as a fish poison (²⁴).

BARRINGTONIA ACUTANGULA (Linn.) Gaertn. It is a small or medium-sized tree most plentiful in Bengal, especially near the coast beyond the tidal range. It is also frequently found in Kanara and Bombay along the banks of streams. The fruit contains two saponins. The bark is used to stupefy fish in many parts of India. The seeds and roots are also said to be used for the same purpose (¹⁸).

BARRINGTONIA ASIATICA (Linn.) Kurz, syn. *B. speciosa* Forst. It is rather a small or moderate sized tree which is a native of the Andaman Islands, Singapore and Ceylon. It also occurs on the Southern Deccan Peninsula, but not in a wild state. The active principle of bark is stated to be a volatile oil combined with a resin. The seeds contain 3.27 per cent. of a glycosidic saponin, barringtonin and 1 per cent. of a substance designated as barringtogenetic. The plant possesses narcotic properties and stupefied fish without killing them. The seeds are also said to be a fish poison (¹³ ²⁶).

BARRINGTONIA RACEMOSA (Linn.) Roxb. This is an evergreen ornamental tree common along the Western Coast from Konkan to Travancore and from the Sundarbans eastwards. The seed is used as a household vermifuge in Madagascar and is stated to be a fish poison. The plant possesses toxic and insecticidal properties (⁹ ²⁷).

BERBERIS ARISTATA DC. (possibly some other species of *Berberis* also.)

CAESALPINIA NUGA (Linn.) Ait. This is a large prickly climber found on the banks of rivers near the Coast, e.g. in Konkan, West Coast, Orissa, the Sundarbans, Eastern Bengal near Chittagong, and in Sylhet. The pulped fruit and stems yield a fish poison (²).

CALLICARPA LONGIFOLIA Lam. var. *lanceolaria* C.B. Clarke. This is a shrub occurring plentifully in Central Bengal, Tippera, Chittagong and in the Khasia Hills up to an altitude of about 3,000 ft. Pammel records *C. longifolia* as poisonous to fishes. It is likely that the variety *lanceolaria* also is a fish poison (⁹).

CAREYA ARBOREA Roxb. It is a medium-sized tree frequently found in the sub-Himalayan tract from the Jumna eastwards, and in Bengal, central, western and southern India, ascending to an altitude of 5,000 ft. The leaves and wood contain tannins, the former to the extent of 19 per cent. The Mundas of Chota Nagpur use the root, bark and the leaves to kill fish. In Mysore the inner bark is rubbed on the shoes to ward off leeches and is said to be quite effective for this purpose (⁹ ¹²).

CASEARIA GRAVEOLENS Dalz. This is a shrub or small tree found in the Upper Gangetic Plain, westwards to Chenab ascending to an altitude of 5,000 ft. and in Garhwal, Kumaon and the Deccan. In Sikkim it is found at an altitude of 1,500 ft. The fruit is used to poison fish.

CASEARIA TOMENTOSA Roxb. It is a shrub or small tree common throughout India especially in open lands, ascending to an altitude of 3,000 ft. in the Himalayas. According to Brandis, the fruit yields a milky acrid juice which is employed to poison fish. Sometimes the crushed fruit is used for the same purpose (¹⁸).

CERBERA MANGHAS Linn. syn. *C. odollam* Gaertn. It is a small tree or a large shrub found throughout India in the salt swamps or on the sea-coast. It is abundant on the Malabar coast but not very common in Bombay State and elsewhere. The seeds contain a poisonous glycoside, cerberin, having a digitalis-like action. Pammel records the plant as a fish poison.

* *CINCHONA CALISAYA* Wedd.

* *CINCHONA OFFICINALIS* Linn.

* *CINCHONA SUCCIRUBRA* Pav. ex Klotzsch.

CLEISTANTHUS COLLINUS Benth. & Hook. f. This is a small tree found in the dry forests of Bundelkhand, Chota Nagpur, Madhya Pradesh, Orissa, Northern Circars, Carnatic, the Deccan especially in Hyderabad and Malabar. The bark contains saponins and tannin. The root, leaf bark and fruit are employed as a fish poison.

CORYPHA UMBRACULIFERA Linn. It is a magnificent palm found in the moist forests of North Kanara, covering extensive areas near the Gairsoppa and Yena rivers, also on Yellapur Ghats. It also occurs in Malabar and Travancore but in a doubtfully wild state. In the rest of tropical India it is occasionally cultivated. The young fruit is pounded up and used for stupefying fish (³⁷).

DAILBERGIA STIPULACEA Roxb. It is a large climbing shrub, often a small erect tree found in the Eastern Himalayas up to an altitude of 4,000 ft.; also in Assam, Khasia Hills and Chittagong. The bark and root of this plant are stated to be used to poison fish (²).

DERRIS FERRUGINEA (Roxb.) Benth. This is a woody climber found in the evergreen forests of Upper Assam down to Darrang and Silsagar. It yields a fair amount of rotenone up to 2.4 per cent. Because of the presence of rotenone, it is very likely that this plant possesses piscicidal and insecticidal properties (^{44' 45}).

DERRIS SCANDENS (Roxb.) Benth. This is a very large climber found in the forests of North Oudh, Konkan, Kanara, Madras State, Bengal especially near Chittagong and Orissa. It is also sometimes cultivated in gardens. It is used as a fish poison and is considered to be devoid of insecticidal properties (⁴⁴).

DERRIS TRIFOLIA Lour. var. *uliginosa* Roxb. ex Willd. Badwar nov. comb. syn. *D. uliginosa* Benth.; *Robinia uliginosa* Roxb. ex Willd. This is a large climber found on the muddy sea coast and creeks of the Bombay and Madras States near the sea from Cuttack tidal forests to Puri (near the Chilka Lake); also in the Sundarbans and Chittagong in Bengal and in Assam. Power examined the stem bark and found it to contain 9.3 per cent. of tannic acid and some resins and concluded that the toxic effects of the plant were probably due to some constituents of the resin. Krishna and Ghose, who examined the roots in different seasons of the year, state that total ether extract of these roots which is supposed to extract most of the insecticidal principle, was found to vary from 1.2 to 1.9 per cent. and although the ether solubles gave distinct colour test for rotenone and allied bodies, no rotenone could be isolated. The bark of this plant is used as a fish poison. The plant possesses very poor insecticidal properties (^{44' 46}).

DIOSCOREA HISPIDA Dennst. syn. *D. daemona* Roxb. It is a climbing plant found throughout India up to an altitude of 2,500 ft. in the Himalayas and upto 4,000 ft. in the Khasia and Naga Hills. It is, however, absent from the plains of Bengal. The tubers contain an alkaloid called dioscorine, which runs through the whole plant. In the Phillippine Islands, poultices of the tubers are applied to wounds which are infested with maggots. Fishes are stated to be poisoned by the tubers. According to Gimlette, the leaves are also used to poison fishes (^{47' 48' 49}).

DIOSCOREA PRAZERI Prain and Burkill syn. *D. deltoidea* Wall. var. *sikkimensis* Prain. It is a climbing plant found in the hill tracts of Northern Bengal, Nepal and Khasia Hills up to an altitude of 5,500 ft. It contains poisonous saponins. The Lepchas use

the rhizome of this plant as a substitute for soap for washing their hair, because it kills lice. They also employ it as a fish poison⁽⁴⁸⁾.

DIOSPYROS EBENUM Koen. It is a large or moderate-sized tree found in the forests of Peninsular India and Assam. Pammel records it as a fish poison⁽⁹⁾.

DIOSPYROS MONTANA Roxb. It is a small or medium-sized tree found throughout India, in the sub-Himalayan tract from Kangra (Punjab) eastwards, upper Gangetic Plain, Bihar, Konkan, Southern Mahratta Country, Andhra the Deccan, Carnatic and eastern slopes of the Ghats. The fruit is stated to be used by the hillmen of Travancore for poisoning fish. Crushed leaves are used for the same purpose in Chota Nagpur ^(8' 18).

DIOSPYROS PANICULATA Daltz. It is a middle-sized West Peninsular tree found in the forests of Southern Mahratta, Kanara, Malabar and Travancore up to 3,000 ft. above sea level. The leaves are used as a fish poison⁽⁸⁾.

DODONAEA VISCOSA (Linn.) Jacq. It is an evergreen shrub, rarely a small tree, met with in the North-West Himalayas up to an altitude of 4,500 ft.; also in Sind and south India up to 8,000 ft. in the Nilgiris. It is commonly planted in northern India as a hedge plant. The plant contains saponins. According to Pammel, the plant is poisonous to fishes ^(9' 50).

DOLICHANDRONE FALCATA Seem. It is a deciduous tree found in Rajasthan Bundelkhand, Bihar, Madhya Pradesh, Berar, Konkan, the Deccan, Mysore and most parts of Madras State in dry deciduous forests and often on rocky places. The bark is used in the neighbourhood of Poona and other places as a fish poison.

EDGEWORTHIA GARDNERI Meissn. It is a large much-branched bush found along the Himalayas from Nepal to Sikkim and Bhutan between altitudes of 4,000 and 9,000 ft. It is also plentiful in Manipur. Pammel on the authority of Greshoff, records it as a fish poison⁽⁹⁾.

* *ENTADA PURSAETHA* DC. syn. *E. scandens* Benth.

EREMOSTACHYS SUPERBA Royle ex Benth. It is an erect herb common on the salt Range of Punjab ascending up to an altitude of 2,500 ft.; it is also met with in and near Peshawar and in Baluchistan. The plant is employed as a fish poison in the Eusafzai country near Peshawar⁽⁹⁾.

EUPATORIUM ODORATUM Linn. It is an obnoxious weed introduced from the West Indies, over extensive areas in Bengal and Assam. It is recorded as poisonous to fishes.

EUPHORBIA NERIFOLIA Linn.

EUPHORBIA ROYLEANA Boiss.

EUPHORBIA TIRUCALLI Linn.

EXCOECARIA AGALLOCHA Linn.

FLUEGGEA LEUCOPYRUS (Koen.) Willd. It is a large rigid bushy shrub found in the sub-Himalayan tracts of Uttar Pradesh (Gorakhpur), outer ranges of the Kumaon Himalayas up to an altitude of 5,000 ft., in the Punjab plains, Sind and throughout Bombay and Madras States usually in open places. The bark contains about 10 per cent. of tannins. The bark is stated to be used as a fish poison⁽¹⁸⁾.

FLUEGGEA VIROSA (Roxb. ex Willd.) Bail. syn. *F. microcarpa* Blume. It is a large unarmed shrub or small tree found throughout India, from the Indus and Kashmir eastwards to Assam in the Himalayas up to an altitude of 5,000 ft., and in the rest of India in deciduous forests. The bark contains about 8.9 per cent. of tannins. The bark is stated to be used as a fish poison⁽¹⁸⁾.

GNETUM SCANDENS Roxb. It is a lofty dioecious climber found in the tropical Eastern Himalayas from Sikkim eastwards to Assam and the Khasia Hills, and through Chittagong, Chota Nagpur and Bihar to the Andamans. In Western India it extends from Konkan southwards to the Ghats of both sides of the Madras State at altitudes of 500 to 5,000 ft. According to Pammel the plant is used as a fish poison⁽⁹⁾.

GYNOCARDIA ODORATA R. Br. It is a glabrous tree common in the evergreen forests of Sikkim and Assam extending eastwards across Chittagong as far as Tenasserim. The seeds freed from the shell yield about 65 per cent. of a fatty oil known as gynocardia oil, which does not contain chaulmoogric acid or its homologues but consists of glycerides of linolic palmitic, linolenic, isolinolenic and oleic acids. Seeds also contain a cyanogenetic glycoside, gynocardin (5 per cent. of shell-free seeds). The seed pulp is employed in Sikkim to poison fish^(57,58).

HARPULLIA CUPANIOIDES Roxb. It is a small tree found in the hill tracts near Chittagong. It contains saponins. Pammel records it as a fish poison^(9,12).

* **HYDNOCARPUS KURZII** (King) Warb. syn *Taraktogenos kurzii* King.

HYDNOCARPUS LAURIFOLIA (Dennst.) Sleumer syn. *H. wirhtiana* Blume.

HYDROCOTYLE JAVANICA Thunb. It is a creeping herb with erect flexuous branches, found from Kashmir to Bhutan at altitudes of 2,000 to 8,000 ft., in the Khasia mountains between 2,000 to 6,000 ft., and in the mountains of the Western Ghats and the Nilgiris and Pulneys, in shady places. It is referred to as a fish poison by Pammel, but no such use is reported in India⁽⁹⁾.

JATROPHA CURCAS Linn. It is a shrub or small tree which is a native of America, grown in various parts of India as a field barrier. It is also found in a semi-wild condition in the vicinity of villages. The seeds contain 20 to 40 per cent. of a fixed oil which is a drastic purgative. They also contain a toxalbumin known as curcin, which is a blood poison. According to Pammel, the plant is poisonous to fishes^(9,64).

JUGLANS REGIA Linn. The walnut tree is found in the temperate Himalayas and Western Tibet at altitudes of 3,000 to 10,000 ft., both wild and under cultivation. It is cultivated in the inner valleys of Kagan, Kashmir, Chamba, Kulu and Bushahr. The plant contains an essential oil, tannins and a hydroxynaphthaquinone derivative. According to Kanjilal, the rind of the unripe walnut fruit is used in Naunsar and Tehri Garwhal to intoxicate fish. The authors have never heard of this very well known plant being put to such use in other parts of the North-West Himalayas^(12, 62, 63).

LASIOSIPHON ERIOCEPHALUS Dcne.

LEPIDIUM DRABA Linn. It is a weed of cultivation in the Punjab. The seeds yield an essential oil containing sulphur compounds. The young leaves yield hydrocyanic acid. The plant is stated to be a fish poison^(9,12).

LINOSTOMA DECANDRUM Wall. It is an erect evergreen shrub found in Sylhet and Chittagong. According to Rodger, fish poisons are extracted from the pulped up fruits and stems of this plant⁽⁶⁵⁾.

MAESA INDICA Wall. It is a large shrub found throughout India up to an altitude of 6,000 ft.; common in the North-East Himalayas, Eastern Bengal, Darjeeling district, Manipur, Kanara and along the Ghats. The leaves are used as a fish poison in Kanara⁽¹³⁾.

MELODINUS MONOGYNUS Roxb. It is a tall climber found in the Sikkim Himalayas, Assam, Sylhet and the Khasia Hills, ascending to an altitude of 4,000 ft. Roxburgh while steeping some of the young shoots in a fish pond in order to accelerate the removal of the bark and to clean the fibre, found that many if not all the fish were killed, hence his name *Nerium piscidium* for the plant.

MILLETTIA PACHYCARPA Benth. It is a large climber found in the forests of Garo and Khasia Hills, Sikkim and Assam up to an altitude of 4,000 ft. The plant contains a large amount of saponin and possibly also considerable quantities of rotenone. It is known as 'fish poisoning vine' in China, the root being commonly used for this purpose. Mixtures of this plant with soap, tea or oil serve not only as a good insecticide but also as contact and stomach poisons; the efficiency for the latter purposes being not inferior to that of Derris.

MILLETTIA PISCIDIA Wight & Arn. It is found in Sikkim and Assam. As the name suggests it is very likely to be poisonous to fish.

MUNDULEA SERICEA (Willd.) Greenway syn. *M. suberosa* Benth. It is a stout shrub or small tree found in western and southern India in Konkan, the Deccan, Carnatic to Tinnevely, in dry forest on rocky hills and up to 4,000 ft. above sea level. According to Pammel the bark and the root contain a very toxic glycoside but we have not been able to verify this. The bark is reported to contain only 0.8 to 0.9 per cent. of rotenone. The seeds are used for poisoning fish in southern and western India; the bark also possesses piscicidal properties. According to Greenway, the plant is stated to be poisonous to crocodiles and to have the effect of driving them away from the river. He also states that the people of Tanganyika sometimes tie the strips of bark round the legs of the cattle, when they are taken to the river to water, in order to protect them from these reptiles. It is very likely that the root is also poisonous to fish. The bark is stated to be almost as toxic to various insects as the roots of *Derris elliptica*, in spite of the low content of rotenone (^{9' 67' 68}).

MYRICA NAGI Thunb. It is a small evergreen dioecious tree found in the outer Himalayas from the Ravi (Punjab) eastwards at altitudes of 3,000 to 6,000 ft.; also in the Khasia Hills and Sylhet. According to Hooper, 100 parts of the 'kino' produced by the bark contain about 60 to 80 parts of tannin. According to Gamble, the bark is used in the Khasia Hills to poison fishes (^{12' 69}).

OUGEINIA DALBERGIOIDES Benth. It is a small or medium-sized tree found in the sub-Himalayan tracts and outer Himalayan valleys and slopes up to an altitude of 5,000 ft. from the Punjab to Bhutan; also in Oudh, Bundelkhand, Chota Nagpur, Central India, Orissa, Madras State, Madhya Pradesh, Bombay State and Marwar i.e., Rajasthan. The bark is employed to poison fish. The stem-bark and leaf are stated to be toxic to some caterpillar pests (⁴⁸).

PITHECELLOBIUM BIGEMINUM Mart. syn. *Pithecellobium bigeminum* Benth. It is a middle-sized unarmed tree found in the Eastern Himalayas, Khasia and Jaintia Hills, Konkan, North and South Kanara, the Western Ghats of Madras State from Mysore to Anamalais and Travancore, ascending to an altitude of 3,000 ft. The bark contains 0.8 per cent. of an alkaloid, which acts as a fatal poison to fish in a dilution of 1:4,00,000; it also contains a saponin. The leaves contain two acids but no alkaloids, glycosides or tannins. The plant is poisonous to fish (^{73' 74' 75}).

* **PONGAMIA PINNATA** (Linn.) Merr. syn. *P. glabra* Vent.

PYGEUM GARDNERI Hook. f. It is a medium-sized tree found in the Western Ghats of Madras and Bombay State, in the hills of Travancore, Malabar, Nilgiris, Pulneys, the Deccan, southern Mahratta Country, and Konkan at altitudes above 3,000 ft.; it is common on the Mahabaleshwar plateau. The seeds smell strongly of hydrocyanic acid. The kernel of the fruit is used as a fish poison.

RANDIA ULIGINOSA DC. A small rigid tree found in the eastern, central and southern India, but is not common northwards. The unripe fruits are employed for poisoning fish.

* **RAUVOLFIA SERPENTINA** Benth. ex Kurz.

RHODODENDRON BARBATUM Wall. ex G. Don. It is a tree found in the temperate Himalayas from Kumaon to Bhutan at altitudes of 8,000 to 12,000 ft. It is common in Sikkim. It contains the toxic substance andromedotoxin. The plant is mentioned by Chopra to be a fish poison (^{10' 72}).

RHODODENDRON FALCONERI Hook. f. It is a tree common in the Himalayas from east Nepal to Bhutan at altitudes of 9,000 to 13,000 ft. It contains a toxic substance, andromedotoxin. Chopra mentions the plant as a fish poison.

* **RICINUS COMMUNIS** Linn.

SAPINDUS MUKOROSI Gaertn. It is a handsome tree cultivated throughout north-west India, Bengal and Assam; also found wild in the Himalayas up to an altitude of 4,000 ft. The fruit contains fairly large amounts of saponins 10.5 cent. The plant is described as a fish poison by Pammel^(9'24).

SAPINDUS TRIFOLIATUS Linn. It is a handsome tree common about the villages in south and west India; also cultivated in Bengal where it is doubtfully native. It is occasionally planted elsewhere also. The pericarp contains a fairly large quantity of saponins (11.5 per cent.). According to Brannet, quoted by Watt, no saponins are contained in the stone. Pammel records it as a fish poison. It is more than probable that *S. emarginatus* Vahl., which is treated as a synonym of *S. trifolius* in the Fl. Brit. Ind., but which is now regarded as distinct species, possesses similar properties. The fruits of both are used as a substitute for soap on account of the large amount of saponins they contain^(9'12'81).

SAPIUM INDICUM Willd. It is an evergreen tree found in the Sundarbans, and in the West coast along backwaters in Malabar and Travancore. The seeds are employed as a fish-intoxicant by local people where the tree is found.

SPHAERANTHUS INDICUS Linn. It is a strongly scented herb found throughout India, especially in damp places and in cultivated fields after harvest, ascending in the Himalayas up to an altitude of 5,000 ft. from Kumaon to Sikkim. The herb contains 0.22 per cent of an essential oil; it is also stated to contain a bitter alkaloid. The Mundas of Chota Nagpur bruise the whole plant and throw it into water to kill fish. It is also stuffed into crab's holes to kill them^(18'85).

STEPHANIA HERNANDIIFOLIA (Willd.) Walp. A slender twining shrub found on the west and east Coast, Cachar, Sikkim, East Bengal and Assam. It probably contains saponins. The extract acts as a strong poison to frogs^(8'85).

STRYCHNOS COLUBRINA Linn. It is a large climbing shrub found in western and southern parts of India in Bombay, Konkan, Poona, Kanara, Carnatic, Veligonda Hills of Nellore, Western Coast from South Kanara to Travancore to the lower forests of the Western Ghats. The roots, seeds, bark and wood contain the alkaloids brucine and strychnine. The seeds are likely to be poisonous to fishes⁽¹²⁾.

* *STRYCHNOS NUX-VOMICA* Linn.

TAXUS BACCATA Linn. It is a small or medium sized evergreen tree met with in the temperate Himalayas at altitudes of 6,000 to 11,000 ft., and in the Khasia Hills at altitudes of 5,000 ft., the leaves, shoots, and fruits contain a toxic alkaloid, taxine. According to Lander the sap contains a volatile oil. Blyth states that the leaves contain much formic acid. The leaves also contain the glycoside taxicatin and small amounts of ephedrine. Pammel records the plant as a fish poison^(9'70'87'89'90).

TEPHROSIA CANDIDA (Roxb.) DC. It is a weak shrub found in the tropical Himalayas from Garhwal to Khasia and Assam. Ascending up to an altitude of 5,000 ft. in Sikkim; in Chittagong and the Sameshwar hills. It is occasionally grown as an ornamental plant. The plant has been recorded by Gamble as a fish poison in Eastern Bengal and Burma; the bark and leaves are chiefly used for this purpose. An extract of the seeds has been tested for its insecticidal properties on small-scale field trials, and found to be quite effective^(69'70).

TEPHROSIA PURPUREA (Linn.) Pers. It is a sub-erect herbaceous perennial found all over India, ascending in the Himalayas up to an altitude of 6,000 ft. The roots contain tephrosin, deguelin, isotephrosin, rotenon, etc. The leaves contain about 2 per cent. of a glycoside, osyritin. The root is used to poison fish in French Guiana, but no such use has been reported in India^(81'92'93).

TERMINALIA BELERICA (Gaertn.) Roxb. It is a large deciduous tree common in the plains and lower hills throughout India with the exception of the arid tracts in the West. The fruits contain 5 to 17 per cent. of tannin. The plant has been reported as a fish

poison, but we have never heard of such a use in India in spite of its great abundance^(9,12).

* *THEVETIA PERUVIANA* (Pers.) Merr. syn. *T. neriifolia* Juss.

VERBASCUM THAPSUS Linn. It is a stout wooly herb found in the temperate Himalayas between 5,000 to 12,000 ft., and in Western Tibet. It also occurs in the Western Ghats and in the Nilgiris in the neighbourhood of Ootacamund where it has been introduced and is now rapidly spreading. The leaves contain an amorphous bitter substance and a saponin; the flowers a saponin and the seeds 0.37 per cent. of a saponin. The root contains a glycoside. According to O'Shaughnessy, the seeds are used for poisoning fish. The present authors have not come across the use of the seeds as a fish poison in India. It is however, likely that the whole plant possesses piscicidal properties, as is apparent from its chemical composition. Pammel also records the plant as a fish poison^(9' 13' 97' 98' 99).

WALSURA PISCIDIA Roxb. It is a small tree found in the Western Ghats from North Kanara to the Anamalais, Pulneys and Travancore; also Andhra, Carnatic. The Deccan, Hazaribagh & Gaya in Bihar and in the Puri Division. The plant is stated to contain saponins. Roxburgh and following him many other workers state that the bark is largely employed to intoxicate fish and that fish so caught are no less wholesome to eat than ordinary fish.

WIKSTROEMIA INDICA (Linn.) C. A. Mey., var. *viridiflora* (Meissn.) Hook. f. It is a bushy shrub found in Chittagong. The plant has been recorded by Pammel as a fish poison⁽⁹⁾.

ZANTHOXYLUM ALATUM Roxb. It is a shrub or a small tree found in the hot valleys of the sub-tropical Himalayas from the Trans-Indus area eastwards to Bhutan up to an altitude of 7,000 ft., also in the Khasia Hills between 2,000 and 3,000 ft., and in the hills of Ganjam and Vizagapatam at about 4,500 ft. The fruits contain about 1.5 per cent. of an essential oil. The bark contains a bitter crystalline principle, which is identical with berberine. It also contains a volatile oil and resins. According to Brandis, the bark is used for killing fish, while Atkinson reports that the fruit is also used for the same purpose^(13,101).

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F. PLANTS CONTAINING POISONOUS PRINCIPLES

A large number of plants growing in India contain poisonous principles and may give rise to toxic symptoms in man and animals. A list of the important plants belonging to this category is given below.

PLANTS CONTAINING HYDROCYANIC ACID AND CYANOGENETIC GLYCOSIDES

Achillea millefolium Linn., *Aquilegia vulgaris* Linn., *Bambusa bambos* Druce, *Catambrosa aquatica* Reauv., *Cirsium arvense* Scop., *Cotoneaster microphylla* Wall., *Cotoneaster vulgaris* Lindl., *Crataegus oxyacantha* Linn., *Gymnema latifolium* Wall., *Gynocardia odorata* R. Br., *Hydrangea aspera* Buch., *Indigofera galeoides* DC., *Ipomoea dissecta* Willd., *Ipomoea sinuata* Ort., *Isopyrum thalictroides* Linn., *Lamarckia aurea* Moench., *Linaria minor* Desf., *Linum usitatissimum* Linn., *Lotus corniculatus* Linn., *Lepidium draba* Linn., *Lycium barbarum* Linn., *Manihot utilisima* Pohl., *Melica ciliata* Duthie., *Modecca wightiana* Wall., *Papaver nudicaule* Linn., *Phaseolus lunatus* Linn., *Photinia serrulata* Lind., *Prunus amygdalus* Baill., *Prunus padus* Linn., *Prunus puddum* Roxb., *Prunus undulata* Ham., *Pyrus aucuparia* Gaertn., *Pyrus cydonia* Linn., *Ranunculus arvensis* Linn., *Ribes grossularia* Linn., *Ribes rubrum* Linn., *Sambucus ebulus* Linn., *Sambucus nigra* Linn., *Schleichera trijuga* Willd., *Solanum tuberosum* Linn., *Sorghum halepense* Pers., *Sorghum saccharatum* Pers., *Sorghum vulgare* Pers., *Spiraea aruncus* Linn., *Spiraea lindleyana* Wall., *Stipa tortilis* Desf., *Stranvaesia glaucescens* Lindl., *Taraktogenos kurzii* King., *Trifolium repens* Linn., *Triglochin maritimum* Linn., *Triglochin palustris* Linn., *Vicia hirsuta* Koch., *Vicia sativa* Linn. var. *angustifolia* Roth.

PLANTS CONTAINING ARSENIC

Allium porrum Linn., *Ananas sativus* Schult., *Avena sativa* Linn., *Cicer arietinum* Linn., *Cichorium intybus* Linn., *Citrus aurantium* Linn., *Cucurbita pepo* DC., *Daucus carota* Linn., *Ervum lens* Linn., *Hedera helix* Linn., *Hordeum vulgare* Linn. syn. *H. sativum* Pers., *Juglans regia* Linn., *Lactuca sativa* Linn., *Linum usitatissimum* Linn., *Nasturtium officinale* R. Br., *Nicotiana tabacum* Linn., *Oryza sativa* Linn., *Pisum sativum* Linn., *Prunus amygdalus* Baill., *Raphanus sativus* Linn., *Spinacia oleracea* Linn., *Tragopogon pratensis* Linn., *Trifolium pratense* Linn., *Triticum sativum* Lam., *Vicia faba* Linn., *Vicia sativa* Linn., *Viscum album* Linn., *Vitis vinifera* Linn., *Zea mays* Linn.

PLANTS CONTAINING OXALIC ACID

Aesculus hippocastanum Linn., *Amaranthus caudatus* Linn., *Calanhus draco* Willd., *Camellia theifera* Griff., *Cassia angustifolia* Vahl., *Cinchona succirubra* Pav., *Crataegus oxyacantha* Linn., *Galium mollugo* Linn., *Juglans regia* Linn., *Juniperus communis* Linn., *Lycopersicon esculentum* Mill. syn. *Solanum lycopersicum* Linn., *Nicotiana tabacum* Linn., *Oxalis acetosella* Linn., *Papaver somniferum* Linn., *Phalaris canariensis* Linn., *Polygonum bistorta* Linn., *Rheum emodi* Wall., *Rubus fruticosus* Linn., *Rumex acetosa* Linn., *Saccharum officinarum* Linn., *Salsola kali* Linn., *Sambucus nigra* Linn., *Solanum tuberosum* Linn., *Tamarindus indica* Linn., *Vitis vinifera* Linn., *Zingiber officinale* Rosc.

PLANTS CONTAINING BARIUM

Juglans regia Linn., *Nicotiana tabacum* Linn., *Prunus avium* Linn., *Ulmus campestris* Linn.

PLANTS CONTAINING LEAD

Molonia coerulea Moench., *Randia dumetorum* Lamk., *Vicia faba* Linn.

SECTION III

THERAPEUTIC AND OTHER USES OF INDIAN MEDICINAL PLANTS

We have carefully studied the literature dealing with indigenous medicine, both Ayurvedic and Unani and have tried to classify the different drugs in common use according to their application by the practitioners of these systems in various diseases met with in India. As a result, we have prepared lists of Indian plants used against different prevailing disease conditions. Our object in giving these lists here is to give an indication to those who wish to take up investigations as to the avenue in which their work may possibly be directed.

1. PLANTS TO WHICH ARE ATTRIBUTED ANTISEPTIC PROPERTIES.—These plants either in their fresh form or in form of watery extracts prepared from them have been used in cleaning and dressing wounds, boils, etc. Majority of these have only a very mild antiseptic action.

2. INDIAN PLANTS CONSIDERED TO BE USEFUL IN THE TREATMENT OF TUBERCULOSIS.—Pulmonary tuberculosis is very common in India and certain plant remedies have been used in the treatment of this disease.

3. INDIAN PLANTS CONSIDERED TO HAVE ANTI-DYSENTERIC PROPERTIES.—The term dysentery or 'Sangrahnī' as it is called in Ayurvedic medicine, is applied to all form of diarrhoeal conditions particularly those in which blood is passed in the stools. No distinction has been made between the amoebic and bacillary types. Such bowel conditions are very common and a large number of these plants have been used in one part of India or the other and at one time or other in their treatment. Some of them are effective in producing a cure, e.g. *Holarrhena antidysenterica* while others are merely palliative due to presence of tannins or mucilaginous substances, e.g. *Aegle marmelos*, *Plantago ovata*, etc.,

4. INDIAN PLANTS CONSIDERED TO BE USEFUL IN SUCH DISEASES AS CHOLERA AND PROLONGED FEVERS (ENTERIC GROUP).—Cholera used to be an endemic disease in some parts of India. Not many years ago Bengal was considered to be the home of Cholera from which it spread to other parts of India as well as other parts of the world. General sanitary conditions and water supply were not satisfactory in old days and this disease took a very heavy toll of life particularly during religious festivals in places of pilgrimage where large masses of humanity collected on these occasions. During the last decade enormous sums of money have been spent on these measures and no epidemics have occurred in places such as Allahabad, Hardwar, Kurukshetra, where millions of people have gathered.

Prolonged fevers such as those belonging to the enteric group are common in India particularly in the urban areas on account of defective drainage of sewage and unsatisfactory sanitary conditions. These also are being gradually improved.

Lists of all these plants are given below :

A. PLANTS ALLEGED TO HAVE ANTISEPTIC PROPERTIES

[*For detailed description refer to Parts II and III]

- * 1. ABRUS PRECATORIUS Linn.
- 2. ABUTILON HIRTUM G. Don. (H. & B.—*Barkhanghi*; M.—*Tutti*).
- 3. ABUTILON INDICUM Sw. (H.—*Kanghi*; B.—*Potari*; Bo.—*Kangori*).
- 4. ABUTILON THEOPHRASTII Medic. (S.—*Jaya*; Bo.—*Nahni khapat*).
- 5. ACACIA ARABICA Willd. (H.—*Kikar*; B.—*Babla, Babul*).
- * 6. ACACIA CATECHU Willd.
- 7. ACALYPHA INDICA Linn. (H. & Bo.—*Khokali*; Tam.—*Kuppaimeni*).
- 8. ADENIA PALMATA Engl. (Mal.—*Mutakku*; Tel.—*Modikka*).
- * 9. ADHATODA VASICA Nees.
- 10. ADIANTUM CAUDATUM Linn. (S.—*Mayurashikha*; P.—*Adhsarita-ka-jari*).
- 11. ADINA CORDIFOLIA Benth. & Hook. (H.—*Haldu*; Tam. & Mal.—*Manja kadamba*).
- 12. AILANTHUS EXCELSA Roxb. (H. & Mar.—*Maharukha*; Tam.—*Peruppi*).
- 13. ALBIZZIA LEBBECK Benth. (S.—*Shirisha*; H., B. & Bo.—*Siris*).
- 13a. ALHAGI CAMELORUM Fisch. syn. A. PSEUDALHAGI Desv. (B.—*Dulal labah*; H.—*Jawasa*).
- * 14. ALOE VERA Linn.
- 15. ALSTONIA SCHOLARIS R. Br.
- 16. ALTINGIA EXCELSA Nor. (H.—*Silaras*; S.—*Silhasara*; Assam.—*Jutuli*).
- 17. AGANOSMA DICHOTOMA K. Schum. (S., H., B. & Tel.—*Malati*).
- 18. AGAVE AMERICANA Linn. (H. & S.—*Kantala*; B.—*Jangli anaras*; Tam.—*Alagai*).
- 19. AGLAIA ODORATISSIMA Blume.
- 20. APIUM GRAVEOLENS Linn. (S.—*Ajamoda*; H.—*Ajmut*; B.—*Chanu*).
- 21. ANOGEISSUS LATIFOLIA Wall. (H.—*Bakla*; B.—*Dhaoya*; S.—*Dhava*).
- 22. AQUILARIA AGALLOCHA Roxb. (S. & B.—*Agaru*; H. & Tam.—*Agar*).
- * 23. ARGEMONE MEXICANA Linn.
- 24. ARGYREIA SPECIOSA Sweet. (Bo.—*Guguli*; Mal. & Tel.—*Samudrapala*).
- * 25. ARTEMISIA ABSINTHIUM Linn.
- 26. ARTEMISIA SIVERSIANA Willd. (B.—*Dona*; Arab.—*Afsantin*).
- 27. ARTOCARPUS HETEROPHYLLUS Lam. syn. A. INTEGRIFOLIA Linn. (S. & Tel.—*Panasa*; H. & B.—*Kanthal, Kathal*).
- 28. ASPARAGUS GONOCADUS Baker. (B.—*Satmuli*; Bo.—*Shatavari*).
- 29. ASTER AMELLUS Linn. syn. A. TRINERVIUS Roxb.
- * 30. AZADIRACHTA INDICA A. Juss.
- 31. BALANITES AEGYPTIACA Del. (S.—*Ingudi*; H. & B.—*Hingan*; Tel.—*Gari*).
- 32. BALIOSPERMUM MONTANUM Muell. (S., H. & B.—*Danti*; Tel.—*Nelajidi*).
- * 33. BAMBUS A ARUNDINACEA Retz.
- 34. BAUHINIA RACEMOSA Lam. (H.—*Kachnal*; B.—*Banraj*; P.—*Kosundra*).
- 35. BAUHINIA VARIEGATA Linn. (S.—*Kovidara*; H.—*Kachnar*; Tel.—*Mandara*).
- 36. BARLERIA COURTALLICA Nees. (M.—*Venkurunji*).
- 36a. BARLERIA PRIONITIS Linn. (Bo.—*Vajra danti*; B.—*Kantajati*; Tam. & Mal.—*Shemmuli*).
- 36b. BARLERIA STRIGOSA Willd. (B.—*Dasi*; Bo.—*Wahiti*; Tam.—*Nili*).
- * 37. BASSIA LATIFOLIA Roxb.
- * 38. BASSIA LONGIFOLIA Linn.
- * 39. BERBERIS ARISTATA DC.
- * 40. BERBERIS ASIATICA Roxb.
- * 41. BERBERIS LYCIUM Royle.
- 42. BERGENIA LIGULATA Engl. (B.—*Patharchuri*; H.—*Pakhanbed*).
- 43. BETULA UTILIS D. Don. (S. & B.—*Bhurjapatra*; H.—*Bhujpattira*).
- 44. BOSWELLIA SERRATA Roxb. (S.—*Shallaki*; H. & B.—*Luban, Salai*).
- 45. BLUMEA BALSAMIFERA DC. (H.—*Kakaronda*; Mar.—*Bhangaruda*).

46. *BRASSICA NIGRA* Koch. (B.—*Raisarisha*; H.—*Aslrai*; Bo.—*Rai*).
- * 47. *BUTEA MONOSPERMA* Kuntze.
48. *CAESALPINIA CRISTA* Linn. (S.—*Kuberakshi*; H.—*Karangu*; B.—*Nata*).
49. *CALAMUS ROTANG* Linn. (H., B. & Bo.—*Chachi bet*; Tam.—*Perambu*).
- * 50. *CALOTROPIS GIGANTEA* R. Br.
51. *CALOPHYLLUM APETALUM* Willd. (Mar.—*Bobbi*; Mal.—*Cherupinnai*).
52. *CALLICARPA LANATA* Linn. (H.—*Bastra*; Mal.—*Nalla-pompil*).
53. *CAPPARIS SEPIARIA* Linn. (S.—*Kakadani*; B.—*Kaliakara*; H.—*Kanthari*).
- * 54. *CARAPA MOLUCCENSIS* Lam.
55. *CAREYA ARBOREA* Roxb. (S., H. & B.—*Kumbhi*; Mal.—*Alam*).
- * 56. *CARICA PAPAYA* Linn.
57. *CARTHAMUS TINCTORIUS* Linn. (H. & B.—*Kusum*; Bo.—*Kusumba*).
58. *CASSIA ALATA* Linn. (B.—*Dadmari*; H.—*Dadmurdan*).
- * 59. *CASSIA ANGUSTIFOLIA* Vahl.
60. *CASSIA AURICULATA* Linn. (H. & B.—*Tarwar*; Tam.—*Avaram*; Mal.—*Avara*).
61. *CASSIA TORA* Linn. syn. *C. OBTUSIFOLIA* Linn. (H. & B.—*Chakanda*; Tam.—*Tagarai*).
62. *CEDRUS DEODARA* Loud. (S. & B.—*Devadaru*; H.—*Deodar*).
63. *CENTRATHERUM ANTHELMINTICUM* Ktze. (B. & H.—*Somraj*; S.—*Somraji*).
64. *CENTIPEDA MINIMA* A. Br. syn. *C. ORBICULARIS* Lour. (H. & B.—*Nakkchikni*).
65. *CICER ARIETINUM* Linn. (H. & Bo.—*Chana*; B. & P.—*Chola*).
66. *CINNAMOMUM PAUCIFLORUM* Nees. (Khasia—*Dinglatlerdop*).
- * 67. *CISSAMPELOS PAREIRA* Linn.
- * 68. *CITRULLUS COLOCYNTHIS* Schrad.
69. *CITRULLUS VULGARIS* Schrad. (H.—*Tarbuji*; B.—*Tarmuz*; Tam.—*Pitcha*).
70. *CLEISTANTHUS COLLINUS* Benth. (H.—*Garari*; B.—*Karlajuri*).
71. *CLEOME CHELIDONII* Linn. f. (Porebunder.—*Ubhitalvani*).
72. *COCCINIA INDICA* W. & A. (S.—*Bimba*; H. & P.—*Kanduri*).
73. *COMMIPHORA ROXBURGHII* Engl. syn. *C. AGALLOCHA* Engl. (B.—*Gugala*; Bo.—*Gugall*).
- * 74. *COMMIPHORA MUKUL* Engl.
75. *CORCHORUS CAPSULARIS* Linn. (B. & H.—*Narcha*; S.—*Kalasaka*).
76. *CORCHORUS FASCICULARIS* Lam. (B.—*Bilnalita*; Ind. Bazar.—*Bhaphali*).
- * 77. *CORIANDRUM SATIVUM* Linn.
78. *CORYDALIS GOVANIANA* Wall. (S.—*Bhutakesi*; H. & B.—*Bhut kesi*).
79. *CRESSA CRETICA* Linn. (H. & B.—*Rudravanti*; Bo.—*Khardi*).
80. *CRINUM ASIATICUM* Linn. (S.—*Nagadamani*; H.—*Pindar*; M.—*Vishamungil*).
- * 81. *CROCUS SATIVUS* Linn.
82. *CROTALARIA JUNCEA* Linn. (S.—*Sana*; H.—*Sunn*; Mal.—*Wuckoo nar*).
83. *CUCURBITA PEPO* Linn. (S.—*Kurkaru*; H.—*Kumra*; Bo.—*Kaula*).
- * 84. *CUMINUM CYMINUM* Linn.
- * 85. *CURCUMA ANGUSTIFOLIA* Roxb.
- * 86. *CURCUMA ZEDOARIA* Rosc.
87. *CYMBOPOGON JWARANCUSA* Schult. (B.—*Karankusa*; Bo.—*Isakhir*; H. & P.—*Lamjak*).
88. *CYNODON DACTYLON* Pers. (B.—*Dubh*; H.—*Dhub*; Tel.—*Harvali*).
89. *CYNOMETRA CAULIFLORA* Linn. (Mal.—*Tripa*; Ceylon.—*Nam-nam*).
90. *CYNOMETRA MIMOSOIDES* Wall.
91. *DAUCUS CAROTA* Linn. (H., B. & P.—*Gajar*; M.—*Gajjara kelangu*).
92. *DATURA ALBA* Nees.
93. *DATURA FASTUOSA* Linn. (B.—*Dhatura*; Bo.—*Dhutura*; Tam.—*Vellummattai*).
- * 94. *DATURA STRAMONIUM* Linn.
95. *DIOSPYROS MELANOXYLON* Roxb. (S.—*Dirghapatraka*; H.—*Tendu*; Uriya.—*Kendu*).

96. *DESMODIUM GANGETICUM* DC. (S. & Bo.—*Shalaparni*; H.—*Sarivan*).
97. *DOLICHOS BIFLORUS* Linn. (S.—*Kulaththa*; H. & Bo.—*Kulthi*).
98. *ECLIPTA ALBA* Hassk. (S.—*Bhringaraja*; H.—*Bhangra*; Tem.—*Garuga*).
99. *ELAEOCARPUS OBLONGUS* Gaertn. (Mal.—*Malankara*; Mar.—*Khas*).
100. *ELETTARIA CARDAMOMUM* O. Kuntze Rav.
101. *EMBELIA RIBES* Burm. (S.—*Vidanga*; P.—*Babrun*; Tam., Tel. & Kan.—*Vayuvilanga*).
102. *EVOLVULUS ALSINOIDES* Linn. (H.—*Sankha pushpi*; Tam.—*Visnukarandi*).
- * 103. *EUCALYPTUS GLOBULUS* Labill.
104. *EUPHORBIA NERIIFOLIA* Linn. (H.—*Schund*; B.—*Mansasij*; P.—*Gangichu*).
- * 105. *FERULA NARTHEX* Boiss.
106. *FICUS ARNOTTIANA* Miq. (S.—*Plaksha*; H.—*Parasipal*; Tam.—*Kagoli*).
107. *FICUS CARICA* Linn. (S.—*Anjira*; H. & B.—*Anjir*; P.—*Iagari*).
108. *FICUS RACEMOSA* syn. *F. GLOMERATA* Roxb. (P.—*Kumbal*; H.—*Gular*).
109. *FICUS LACOR* Ham. (S.—*Plaksha*; H. & P.—*Pilkhan*).
110. *FICUS RETUSA* Linn. (B. & H.—*Kamrup*; Bo.—*Pilala*).
- * 111. *FOENICULUM CAPILLACEUM* Gilb.
112. *GARDENIA GUMMIFERA* Linn. (Bo.—*Dikamali*; Tam.—*Tikkamalli*).
113. *GARDENIA FLORIDA* Linn. (S.—*Gandharaj*; M.—*Karinga*).
114. *GARDENIA JASMINOIDES* Ellis. (S.—*Gandharaj*; M.—*Karinga*).
115. *GARDENIA LUCIDA* Roxb. (H. & Mar.—*Dikmali*; S.—*Jantuka*).
- * 116. *GAULTHERIA FRAGRANTISSIMA* Wall.
117. *GEUM ALATUM* Wall. (Kash.—*Gogjimul*; Pers.—*Gunglujungh*).
118. *GEUM URBANUM* Linn.
119. *GIDSEKIA PAHRNACEOIDES* Linn. (S. & B.—*Valuka*; H.—*Balukasag*).
120. *GIRONNIERA RETICULATA* Thwaites. (Nep.—*Sukar*; Lepcha.—*Sheekung*).
121. *GOSSYPIUM HERBACEUM* Linn. (S.—*Karpasi*; H., B. & Bo.—*Kapas*).
- * 122. *GLYCYRRHIZA GLABRA* Linn.
123. *GRANGEA MADERASPATANA* Por. (H.—*Mustaru*; B.—*Namuti*; Mal.—*Nelampala*).
124. *GYMNEMA SYLVESTRE* R. Br. (H.—*Merasingi*; Bo.—*Kavali*).
125. *GYNOCARDIA ODORATA* R. Br. (H., B. & Bo.—*Chaulmogra*).
126. *HELIANTHUS ANNUUS* Linn. (H. & B.—*Surjamukhi*; M.—*Sariyakundi*).
- * 127. *HEMIDEMUS INDICUS* R. Br.
128. *HETEROPHRAGMA ROXBURGHII* DC. (Bo. & Mar.—*Warras*; Kan.—*Bechadi*).
129. *HIBISCUS ESCULENTUS* Linn. (P. & H.—*Bhindi*; Tam.—*Vendi*).
130. *HIPTAGE BENGHALENSIS* Kurz. (S.—*Mudhavi*; H. & B.—*Mudhavilata*).
- * 131. *HOLARRHENA ANTIDYSENTERICA* Wall.
132. *HUMULUS LUPULUS* Linn. (Eng.—*Hop*).
- * 133. *HYDROCOTYLE ASIATICA* Linn.
134. *HYDROLEA ZEYLANICA* Vahl. (B.—*Isha langulya*; Mal.—*Cherivallet*).
135. *HYPERICUM PERFORATUM* Linn. (H. & P.—*Basant*; Urdu—*Balsana*).
136. *HYPTIS SUAVEOLENS* Poit. (Urya.—*Ganugatulsi*).
137. *INDIGOFERA TINCTORIA* Linn. (H. & B.—*Nil*; Bo.—*Nila*).
138. *JASMINUM GRANDIFLORUM* Linn. (S. & H.—*Chambeli*; B.—*Chameli*).
- 138a. *JASMINUM SAMBAC* Alit. (S.—*Mallika*; H.—*Motia*, *Mugra*).
139. *JATROPHA MULTIFIDA* Linn. (S.—*Vishabhadra*; Tam.—*Malaiyamanaku*).
140. *LACTUCA SERRIOLA* Linn. (P., B. & H.—*Kahu*; Tel.—*Kavu*).
141. *LAMFRACHAENIUM MICROCEPHALUM* Benth. (S.—*Ajadandi*; Bo.—*Bramhadandi*).
142. *LAWSONIA INERMIS* Linn. (H.—*Mehndi*; B.—*Mehedi*; Tel.—*Gorinta*).
143. *LEUCAS CEPHALOTES* Spreng. (S.—*Drona pushpi*; H.—*Goma*; P.—*Maldoda*).
144. *LENS CULINARIS* Medic syn. *L. ESCULENTA* Moench. (B.—*Masuri*; H. & S.—*Masur*).

145. *LEPIDAGATHIS CRISTATA* Willd. (Bo.—*Kolichechutar*; Santh.—*Otdhompō*).
146. *LEPIDIUM SATIVUM* Linn. (S.—*Chandra shura*; B., H. & P.—*Halim*).
147. *LIMNOPHILA INDICA* Bruce syn. *L. GRATIOLIDES* R. Br. (S.—*Ambuja*; H.—*Kuttra*; B.—*Karpur*).
148. *LIMNOPHILA GRATISSIMA* Blume Bijdr. (Vern. names as of *L. INDICA*).
149. *LEONOTIS NEPETAEFOLIA* R. Br. (B. & H.—*Hefurchci*).
150. *LINUM USITATISSIMUM* Linn. (H.—*Alsi*; Tam.—*Alshi*; S. & Tel.—*Atasi*).
151. *LITSEA CHINENSIS* Lam. (H.—*Garbijaur*; S.—*Vasa*; Tam.—*Ama*).
152. *LUFFA ACUTANGULA* var. *AMARA* Clarke. (S.—*Koshataki*; B.—*Jhinga*).
153. *LUFFA ECHINATA* Roxb. (Bo.—*Kukarvel*; H.—*Ghagarabela*).
- 153a. *LYONIA OVALIFOLIA* Drude syn. *PIERISOVALIFOLIS* D. Don. (H.—*Ayar*; P.—*Arwan*).
154. *MALVA ROTUNDIFOLIA* Linn. (H. & Bo.—*Khubasi*; Kan.—*Kadukadalegida*).
155. *MALVA SYLVESTRIS* Linn. (H.—*Gul-khair*; Bo.—*Khubasi*; Urdu.—*Khubagi*).
156. *MANGIFERA INDICA* Linn. (H., B. & Bo.—*Am*; Mal.—*Amram*).
157. *MELALEUCA LEUCADENDRON* Linn. (H. & Bo.—*Kayaputis*; B.—*Cajuputte*).
- * 158. *MELIA AZEDARACH* Linn.
- * 159. *MENTHA PIPERITA* Linn.
160. *MOLLUGO OPPOSITIFOLIA* Linn. (S.—*Phanija*; H. & B.—*Jima*).
161. *MOLLUGO PENTAPHYLLA* Linn. (B.—*Julpapra*; Bo.—*Jharas*; Oriya.—*Potagohum*).
162. *MOMORDICA CHARANTIA* Linn. (S.—*Sushavi*; H. & P.—*Karela*).
163. *MOMORDICA DIOICA* Roxb. (S.—*Vahisi*; H.—*Golkandra*; Bo.—*Kurtoli*).
164. *MORINGA OLEIFERA* Lam. (S.—*Sobhanjana*; H. & P.—*Soanjna*).
165. *MUSA PARADISIACA* Linn. syn. *M. SATIENTUM* Linn. (S.—*Rambha*; H. & Bo.—*Kela*).
166. *MYRTUS COMMUNIS* Linn. (H. & P.—*Vilayiti mehndi*; B.—*Sutasowa*).
167. *NARDOSTACHYS JATAMANSI* DC. (S., H. & B.—*Jatamansi*; Garhwal.—*Masi*).
168. *NEPETA GLOMERULOSA* Boiss. (Baluchi.—*Chanjanbutai*).
- * 169. *NICOTIANA TABACUM* Linn.
170. *NYCTANTHES ARBORTRISTIS* Linn. (S.—*Sephalika*; P., H. & B.—*Harsinghar*).
171. *OCIMUM GRATISSIMUM* Linn. (S.—*Vridhdhatulsi*; H. & B.—*Ramtulsi*).
172. *ONOSMA BRACEATUM* Wall. (B. & Urdu.—*Goozaban*; H.—*Shankhahuli*).
173. *ONOSMA ECHIOIDES* Linn. (H. & P.—*Ratanjot*; S.—*Dhamani*).
174. *OPUNTIA DILLENII* Haw. (S.—*Vidara*; H. & B.—*Nagphana*).
175. *OROXylum INDICUM* Vent. (S.—*Shyonaka*; H.—*Arlu*; B.—*Sona*).
176. *OUGEINIA OJENINENSIS* Roxb. (S.—*Tinisha*; H.—*Sandan*; B.—*Tinis*).
177. *OXALIS CORNICULATA* Linn. (S.—*Amlika*; H. & B.—*Amrul*; Bo.—*Ambuti*).
178. *OXYSTELMA ESCULENTUM* R. Br. (S.—*Dugdihika*; H. & B.—*Dudhialata*).
179. *PANICUM ANTIDOTALE* Retz. (H.—*Gunara*; P.—*Ghamur*; Bo.—*Dusto*).
180. *PASSIFLORA FOETIDA* Linn. (S.—*Mukkoopera*; Tam.—*Siruppunaikkali*).
181. *PERGULARIA EXTENSA* N. E. Br. (B.—*Chagulbanti*; Bo.—*Utarni*).
182. *PHASEOLUS RADIATUS* Linn. (S.—*Masha*; H.—*Urid*; Bo.—*Udid*).
183. *PHYLLANTHUS EMBLICA* Linn. (H.—*Aoula*; B.—*Amlaki*; Bo.—*Amla*).
184. *PHYLLANTHUS NIRURI* Linn. (H.—*Jar-amla*; B.—*Bhui-amla*).
185. *PHYLLANTHUS SIMPLEX* Retz. (Bo.—*Bhuiavali*; M.—*Uchchiyusirika*).
186. *PHYLLANTHUS URINARIA* Linn. (S.—*Tamravalli*; H. & B.—*Hayarmani*).
187. *PINUS LONGIFOLIA* Roxb. (H. & P.—*Chir*; S. & Tel.—*Sarala*).
188. *PIPER LONGUM* Linn. (S.—*Pippali*; H.—*Pipal*; M.—*Pippallu*).
189. *PIPER NIGRUM* Linn. (S.—*Maricha*; H.—*Golmirch*; Bo.—*Kala miri*).
190. *PISTACIA INTEGERRIMA* Stew.
191. *PISTIA STRATIOTES* Linn. (S.—*Kumbhika*; H.—*Jalkhumbhi*; Bo.—*Prashni*).
192. *PLATANUS ORIENTALIS* Linn. (P. & Kash.—*Buin*).
193. *PLUMERIA ACUTIFOLIA* Poir. (S.—*Kashira chanmpa*; H. & Bo.—*Khair champa*).

194. POLYGALA CROTALARIOIDES Ham.
195. POLYGALA TELEPHIOIDES Willd.
196. POLYGONUM VIVIPARUM Linn. (P. & Kash.—*Mashum*).
197. PONGAMIA GLABRA Vent.
198. PORTULACA OLERACEA Linn. (S.—*Lonika*; H.—*Khursa*; Bo.—*Kurfah*).
199. PORTULACA QUADRIFIDA Linn. (S.—*Upadyki*; H. & B.—*Lonja*).
200. PSORALEA CORYLIFOLIA Linn. (S.—*Vakuchi*; H. & B.—*Babachi*).
201. PTEROCARPUS MARSUPIUM Roxb. (H.—*Bigasar*; B.—*Pitsal*; Bo.—*Bibla*).
202. PTEROCARPUS SANTALINUS (S., H., B. & Bo.—*Raktachandana*).
203. PTEROSPERMUM ACERIFOLIUM Willd. (S.—*Karnikara*; H.—*Kaniar*; B. & Bo.—*Kanak champa*).
204. PTEROSPERMUM SUBERIFOLIUM Lam. (H. & B.—*Muchukunda*; M.—*Taddai*).
205. PUNICA GRANATUM Linn. (S.—*Darimba*; H.—*Anar-ke-per*; B.—*Dalinm*).
206. RADERMACHERA XYLOCARPA K. Schum. (Bo.—*Kursingh*; Tam.—*Vadencarna*).
207. RANDIA DUMETORUM Lamk. (S.—*Madana*; H.—*Mainphal*; Bo.—*Gelaphal*).
208. RHINACANTHUS NASUTUS Kurz. (S.—*Juthika purni*; B.—*Juipana*).
209. ROUREA SANTALOIDES W. & A. (Bo.—*Vadara*).
210. RUBIA CORDIFOLIA Linn. (S. & B.—*Manjistha*; Bo.—*Manjit*).
211. RUMEX DENTATUS Linn. (S.—*Changeri*; H.—*Ambavati*; H.—*Amrule*).
212. RUMEX VESICARIUS Linn. (S.—*Chukra*; H., B. & Bo.—*Chuka*).
213. SAGITTARIA SAGITTIFOLIA Linn. (B.—*Chotokut*).
214. SALACIA OBLONGA Wall. (M.—*Ponkoranti*).
215. SALACIA RETICULATA Wight. (S.—*Ekanayakam*; M.—*Koranti*).
- * 216. SANTALUM ALBUM Linn.
217. SCHLEICHERA TRIJUGA Willd. (H.—*Kosum*; Bo.—*Kosom*; M.—*Pu-maram*).
218. SEMECARPUS ANACARDIUM Linn.
219. SESBANIA ACULEATA Pers. (S., H. & B.—*Jayanti*; Bo.—*Ranshetra*).
220. SOLANUM DULCAMARA Linn. (S.—*Kakmachi*; P.—*Ruba-barik*).
221. SOLANUM INCANUM Linn.
222. SOLANUM NIGRUM Linn. (Bo.—*Mako*; A.—*Makoi*; S. & B.—*Kakmachi*).
223. SHOREA ROBUSTA Gaertn. (S.—*Sala*; H., P., B. & Bo.—*Sal*).
224. STRYCHNOS COLUBRINA Linn. (H. & B.—*Kuchila-lata*; M.—*Nagamushti*).
- * 225. SWERTIA CHIRATA Ham. ex. Wall.
226. TERMINALIA CATAPPA Linn. (H. & Bo.—*Jangli badam*; B.—*Bangla badam*).
- * 227. TINOSPORA CORDIFOLIA (Willd.) Miers.
228. TRAPA BISPINOSA Roxb. (B.—*Paniplul*; H. & M.—*Singhara*).
229. TRIBULUS TERRESTRIS Linn. (S.—*Gokshura*; H.—*Chotagokhru*).
230. TRICHOLEPIS GLABERRIMA DC. (Bo., S. & H.—*Bramhadandi*).
231. URGINEA INDICA Kunth. (S.—*Vana-palandam*; H. & B.—*Jangli-piyaz*).
- * 232. VITEX NEGUNDO Linn.
233. WAGATEA SPICATA Dalz. (Bo.—*Vagati*).
234. WEDELIA CALENDULACEA Less. (H. & B.—*Bhangra*; S.—*Pitabhringi*).
235. WITHANIA SOMNIFERA Dunal.
236. WRIGHTIA TINCTORIA R. Br. (S.—*Sveta kutanja*; B.—*Indrajau*).
237. XYRIS ANCEPS Lam. (M.—*Kochelachi-pullu*).
238. ZINGIBER CASSUMUNAR Roxb. (P.—*Banada*).
- * 239. ZINGIBER OFFICINALE Rosc.
240. ZINGIBER ZERUMBET Rosc. (P.—*Kachur*, *Nar kachur*).

B. PLANTS ALLEGED TO HAVE ANTI-TUBERCULAR PROPERTIES

[*For detailed description refer to Parts II and III]

- * 1. *ABRUS PRECATORIUS* Linn.
- * 2. *ADHATODA VASICA* Nees.
- * 3. *AEGLE MARMELOS* Corr.
- * 4. *ALANGIUM SALVIIFOLIUM* (Linn. f.) Wang. syn. *A. LAMARCKII* Thwaites.
- 5. *ALBIZZIA JULIBRISSIN* Durazz. (B.—*Kalkora*; H.—*Lal siris*).
- 6. *ALBIZZIA LEBBECK* Benth. (S.—*Shirisha*; H., B. & Bo.—*Siris*).
- 7. *ALLIUM CEPA* Linn. (S.—*Palandu*; H.—*Piyaz*; B.—*Piyaj*; Bo.—*Kanda*).
- * 8. *ALLIUM SATIVUM* Linn.
- * 9. *ALLIUM SCHOENOPRASUM* Linn.
- * 10. *ALPINIA GALANGA* Willd.
- 11. *ASCLEPIAS CURASSAVICA* Linn.
- * 12. *ASPARAGUS RACEMOSUS* Willd. (S. & B.—*Shatamuli*; H.—*Shatawar*; Bo.—*Satavari*).
- * 13. *AZADIRACHTA INDICA* A. Juss. (syn. *MELIA AZADIRACHTA* Linn.)
- 14. *BAUHINIA MACROSTACHYA* Wall. (B.—*Gunda-gilla*).
- 15. *BAUHINIA RACEMOSA* Lam. (S.—*Svelakanchan*; H.—*Kachnal*).
- 16. *BAUHINIA VARIEGATA* Linn. (S.—*Kovidara*; H.—*Kachnar*; B.—*Rakta kanchan*).
- * 17. *BUTEA MONOSPERMA* (Lam.) Kuntze.
- 18. *CANSCORA DECUSSATA* Schult. (S.—*Sankhapushpi*; H.—*Sankhaphuli*).
- 19. *CAPPARIS SPINOSA* Linn. (S.—*Kakadani*; H. & P.—*Kabra*).
- * 20. *CASSIA FISTULA* Linn.
- 21. *CASSIA TORA* Linn. syn. *C. OBTUSIFOLIA* Linn. (S.—*Chakramarda*; H. & B.—*Chakunda*).
- 22. *CIMICIFUGA FOETIDA* Linn. (P.—*Jiuntin*).
- 23. *CITRULLUS COLOCYNTHIS* Schrad.
- 24. *CLERODENDRON SERRATUM* (Linn.) Moon. (H.—*Barnagi*; S. & Bo.—*Bharangi*).
- 25. *CLITORIA TERNATEA* Linn.
- 26. *COCCINIA CORDIFOLIA* Cogn. syn. *C. INDICA* W. & A., *CEPHALANDRA INDICA* Naud.
- 27. *COCOS NUCIFERA* Linn. (H.—*Nariyal*; Bo.—*Narel*; Tam.—*Tankai*).
- 28. *COCCULUS HIRSUTUS* Diels. (B.—*Iluyer*; Bo.—*Vasanvel*; H.—*Jamutiki-bel*).
- * 29. *COMMIPHORA MUKUL* Engl. syn. *BALSAMODENDRON MUKUL* Hook. ex Stock.
- 30. *COMMIPHORA AGALLOCHA* Engl. (B., Bo. & H.—*GUGGUL*).
- 31. *CORIANDRUM SATIVUM* Linn. (S.—*Dhanyaka*; H.—*Dhania*; B.—*Dhan*).
- 32. *CRATAEVA NURVALA* Ham. (H.—*Barun*; S.—*Varuna*).
- 33. *CRESSA CRETICA* Linn. (H. & B.—*Rudravanti*; Bo.—*Khardi*).
- 34. *CUMINUM CYMINUM* Linn. (S.—*Jiraka*; H.—*Jira*, *Zira*, Tam.—*Shiragam*).
- 35. *CURCUMA ANGUSTIFOLIA* Roxb. (H. & B.—*Tikhur*; Tam.—*Kua*).
- 36. *CURCUMA ZEDOARIA* Rosc.
- 37. *DIOSPYROS MELANOXYLON* Roxb. (H. & Bo.—*Tendu*; Tam.—*Tumbi*).
- 38. *DRYNARIA QUERCIFOLIA* J. Sm. (Bo.—*Basingh*, S.—*Ashva katri*).
- 39. *ELETTARIA CARDAMOMUM* Maton.
- 40. *EMBELIA TSJERIAM-COTTAM* A. DC. (H.—*Bayabirang*; Bo.—*Barbatti*).
- 41. *EULOPHIA NUDA* Lindl. (S.—*Manya*; H.—*Goruma*; B.—*Budbar*).
- 42. *FRITILLARIA CIRRHOSA* Don. Prodr.
- 43. *FRITILLARIA ROYLEI* Hook.
- 44. *GERANIUM ROBERTIANUM* Linn.
- * 45. *GLYCYRRHIZA GLABRA* Linn.
- 46. *GMELENA ARBOREA* Linn. (S.—*Gumbhari*; H.—*Kambari*).
- 47. *GOSSYPIUM ARBOREUM* Linn. (H.—*Nurma*; P.—*Kapas*).

- GRAPTOPHYLLUM PICTUM (L.) Griff. (M.—*Ysjudemaram*).
49. GREWIA ASIATICA Linn. (S.—*Parusha*; H. & B.—*Phalsa*).
 50. HAUCLEA SESSILIFOLIA Roxb.
 51. HYSSOPUS OFFICINALIS Linn. (H.—*Zufah-yabis*; Urdu.—*Zufah*).
 52. INDIGOFERA TINCTORIA Linn. (S.—*Nilika*; H. & B.—*Nil*).
 53. JASMINUM AURICULATUM Vahl. (S. & Tel.—*Magadhi*).
 54. LACTUCA SERRIOLA Linn. syn. L. SCARIOLA Linn. (H.—*Kahoo*; B.—*Salad*).
 55. LEEA AEQUATA Linn. (S., H. & B.—*Kakajangha*).
 56. LINUM USITATISSIMUM Linn.
 57. LITSEA CHINENSIS Lam. (H.—*Garbijaur*; B.—*Kukarchita*).
 58. LORANTHUS ASPER Lour.
 59. LUFFA ACUTANGULA var. AMARA Clarke.
 60. LUFFA ECHINATA Roxb.
 61. LUVUNGA SCANDENS Ham.
 62. MACHILUS MACRANTHA Nees. (Tam.—*Kolamavu*; Mal.—*Uravu*).
 - * 62a. MADHUCA INDICA J. F. Gmel. syn. BASSIA LATIFOLIA Roxb. (B., Bo. & H.—*Mahua*).
 63. MARTYNIA ANNUA Linn. (H.—*Bichu*; B.—*Baghnoki*; Tel.—*Garuda-mukku*).
 64. MELISSA PARVIFLORA Benth. (H.—*Bililotan*).
 65. MIMUSOPS HEXANDRA Roxb. (S.—*Rajadani*; H.—*Khirmi*; M.—*Palla*).
 66. MOMORDICA DIOICA Roxb. (S.—*Vahisa*; M.—*Palupaghel kalung*).
 67. MORINGA OLEIFERA Lam.
 68. MUSA SAPIENTUM O. Kuntze.
 69. OCHNA PUMILA Ham. ex. D. Don. (Santh.—*Champabaha*).
 70. OLDENLANDIA UMBELLATA Linn. (M.—*Saya*; H.—*Chirval*).
 71. OPERCULINA TURPETHUM (Linn.) Silva Manso.
 72. PHASEOLUS ACONITIFOLIUS Jacq. (H. & P.—*Moth*; Tam.—*Tulkapyrai*).
 73. PHASEOLUS TRILOBUS Ait. (H. & B.—*Mugani*).
 74. PIPER CHABA Hunter. (S.—*Chavika*; H.—*Chab*).
 - * 75. PIPER LONGUM Linn. (S.—*Püppali*; H.—*Pipal*).
 - * 76. PINUS ROXBURGHII Sargent syn. P. LONGIFOLIA Roxb.
 - * 77. PISTACIA INTEGERRIMA Stew.
 78. PISTIA STRATIOTES Linn. (H.—*Jalqumbhi*; Bo.—*Prashni*).
 79. PLANTAGO MAJOR Linn. (H.—*Lahuriya*; Bo.—*Bartang*).
 80. PLUMBAGO ZEYLANICA Linn.
 81. POLYTOCA BARBATA Stapf. (B.—*Gurgur*; H.—*Kansa*; S.—*Kanda*).
 82. RHODODENDRON CAMPANULATUM Wall. ex G. Don. (H.—*Cherailu*; Kash.—*Gaggar*).
 83. RHUS SUCCEDANEA Linn.
 84. SANSEVIERIA ROXBURGHIANA Schult. (B.—*Murba*; Bo.—*Morwa*).
 85. SANTALOIDES MINUS Schellenb. syn. ROUREA SANTALOIDES W. & A. (B.—*Vitaraka*; Bo.—*Vardara*).
 86. SAPINDUS TRIFOLIATUS Linn. (S.—*Phenila*; H., B. & Bo.—*Ritha*).
 87. SESBANIA SESBAN (Linn.) Merr. syn. S. AEGYPTIACA Poir. (S., H. & B.—*Jayanti*).
 - * 88. SIDA CORDIFOLIA Linn.
 89. SIDA RHOMBIFOLIA Linn.
 90. SOLANUM TRILOBATUM Linn. (S.—*Alarka*; M.—*Tuduvalai*).
 91. SPHAERANTHUS INDICUS Linn. (S.—*Mundirika*; H. & Bo.—*Gorakhmundi*).
 92. SPONDIAS PINNATA Kurz. (S.—*Amratarka*, H., B. & Bo.—*Amra*).
 93. STEPHANIA GLABRA Roxb.
 94. STREBLUS ASPER Lour. (H.—*Siora*; B.—*Sheora*).
 95. TERAMNUS LABIALIS Spreng. (S.—*Masha-parui*; H.—*Mashparui*).
 96. URTICA DIOICA Linn. (H. & P.—*Bichu*).
 97. VANDA SPATHULATA Spreng. (Mal.—*Ponnam-penmaraiva*).

98. *VATERIA INDICA* Linn. (S.—*Ajakarna*; H.—*Safed damar*).
99. *VERBASCUM THAPSUS* Linn.
100. *VERNONIA CINEREA* Less. (S. & H.—*Sahadevi*; B.—*Kukseem*).
101. *VERNONIA ROXBURGHII* Less.
102. *WITHANIA SOMNIFERA* Dunal.
103. *ZIZYPHUS JUJUBA* Lam. (S.—*Badari*; H.—*Baer*; B.—*Kul*; Tam.—*Ilandai*).

C. PLANTS CONSIDERED TO BE USEFUL IN CHOLERA AND PROLONGED FEVERS (ENTERIC GROUP)

[*For detailed description refer to Parts II and III]

- * 1. *ACONITUM FEROX* Wall.
2. *ARTABOTRYS SUAVEOLENS* Blume.
3. *BLUMEA LACERA* DC. (B.—*Kukursunga*; Bo.—*Nimrudi*).
4. *CAPPARIS ZEYLANICA* Linn. (H.—*Ardanda*; B.—*Kalu-ker*a).
5. *CAPSICUM FRUTESCENS* Linn. syn. *C. MINIMUM* Roxb.
6. *CARAPA MOLUCCENSIS* Lam. (B.—*Pussur*).
- * 7. *CASSIA ANGUSTIFOLIA* Vahl.
8. *DESMODIUM GANGETICUM* DC. (S. & Bo.—*Shalparni*; H.—*Sarivan*).
9. *DRYNARIA QUERCIFOLIA* J. Smith. (Bo.—*Basingh*; S.—*Ashvakatri*).
10. *ELAEOCARPUS TUBERCULATUS* Roxb. (S.—*Rudraksha*; M.—*Rutthrak sham*).
11. *ERYCIBE PANICULATA* Roxb. (Santh.—*Kari*; Tam.—*Unamkodi*).
12. *ERYTHROXYLUM MONOGYNUM* Roxb. (M.—*Devadaru*).
- * 13. *EUPHORBIA HELIOSCOPIA* Linn.
14. *FAGONIA CRETICA* Linn. (H.—*Damahan*; P.—*Dama*).
15. *FLACOURTIA INDICA* Meer. syn. *F. RAMONTCHI* L'Herit. (B.—*Bincha*).
16. *GREWIA HIRSUTA* Vahl. (Bo.—*Gowali*; H.—*Kukurbicha*).
17. *GREWIA MICROCOS* Linn. (M.—*Kottakka*).
18. *KALANCHOE SPATHULATA* DC.
19. *LODOICEA MALDIVICA* Pers. syn. *L. SEYCHELLARUM* Labill. (H. & Bo.—*Darya-hanaryal*).
20. *MARRUBIUM VULGARE* Linn. (H.—*Pahari gandana*).
21. *MOMORDICA CHARANTIA* Linn. (H.—*Karela*; B.—*Karala*; Bo.—*Karla*).
22. *MUSA PARADISIACA* Linn. var. *SAPIENTUM* Kuntze. syn. *M. SAPIENTUM* Linn. (S.—*Rambha*; H. & Bo.—*Kela*).
23. *OLDENLANDIA AURICULARIA* K. Schum. (B.—*Muttia-lata*; Bo.—*Dapoli*).
24. *POINCIANA PULCHERRIMA* Linn. syn. *CAESALPINIA PULCHERRIMA* Swartz. (B.—*Krishnachura*; S. & Tel.—*Ratmagandhi*).
25. *PSIDIUM GUAJAVA* Linn. (H.—*Amrud*; Bo.—*Perala*).
26. *SAPINDUS TRIFOLIATUS* Linn.
27. *SCHLEICHERA OLEOSA* (Lour.) Merr. syn. *S. TRIJUGA* Willd.
28. *SCHWEINFURTHIA SPHAEROCARPA* Br. (S., A., H. & Bo.—*Sanipat*).
29. *SOLANUM MELONGENA* Linn. (S.—*Bartaku*; H.—*Baigun*).
30. *SOPHORA TOMENTOSA* Linn. (Burm.—*Thimbawmagyi*).
- * 31. *STRYCHNOS NUX-VOMICA* Linn.
- * 32. *TERMINALIA CHEBULA* Retz.
33. *TERMINALIA CITRINA* Fleming. (H.—*Harira*; B.—*Haritaki*).
34. *TERMINALIA PANICULATA* Roth. (Bo.—*Kindal*; Tam.—*Pumarudu*).
35. *TRACHYSPERMUM AMMI* (Linn.) Sprague syn. *CARUM COPTICUM* Benth.
36. *ZANTHOXYLUM BUDRUNGA* Wall. (B.—*Bazinali*; Bo.—*Tessul*; H.—*Badrang*).

D. PLANTS CONSIDERED TO HAVE ANTI-DYSENTERIC PROPERTIES

[*For detailed description refer to Parts II and III]

- * 1. ABRUS PRECATORIUS Linn.
2. ABUTILON INDICUM Sw. (H.—*Kanghi*; B.—*Potari*).
3. ABUTILON THEOPHASTII Medic. (S.—*Jaya*; Bo.—*Nahani khapat*).
4. ACACIA ARABICA Willd. (H.—*Kikar*; B.—*Babla*).
5. ACACIA CATECHU Willd. (H.—*Khadira*; H.—*Khair*).
6. ACACIA FERRUGINEA DC. (Nep.—*Khaur*; Bo.—*Ker*).
- * 7. ACORUS CALAMUS Linn.
- * 8. ADANSONIA DIGITATA Linn. (H. & Bo.—*Gorakh-amli*).
- * 9. ADHATODA VASICA Nees.
- * 10. ADIANTUM LUNULATUM Burm. (H. & B.—*Kali-jhant*; Bo.—*Hansraj*).
- * 11. ADINA CORDIFOLIA Benth.
- * 12. AEGLE MARMELOS Corr.
13. AGARICUS OSTREATUS (Jacq.) Fries. (Bo.—*Phanasa-alambe*).
14. AGERATUM CONYZOIDES Linn. (B.—*Dochunty*; Bo.—*Osari*).
15. AILANTHUS ALTISSIMA (Mill.) Swingle syn. A. GLANDULOSA Desf. (English.—*Ailanto*).
16. AILANTHUS EXCELSA Roxb. (S.—*Mahanimba*; Tam.—*Peruppi*).
17. AILANTHUS MALABARICA DC. (Bo.—*Guggula-dhup*; Tel.—*Maddi-palu*).
18. ALBIZZIA LEBBECK Benth.
- * 19. ALSTONIA SCHOLARIS R. Br.
- * 20. ALTHAEA ROSEA Cav.
- * 21. AMOMUM XANTHIODES Wall. (H.—*Ilayechi*; Tam.—*Elam*).
22. AMARANTHUS TRICOLOR Linn. syn. A. GANGETICUS Linn. (H.—*Lalsag*; S.—*Marisha*).
23. ANDROGRAPHIS PANICULATA Nees. (S.—*Bhunimba*; H.—*Kiryat*).
24. ANNONA MURICATA Linn. (Mal.—*Mullanjakka*; Tam.—*Mullu-chitta*).
25. ANNONA RETICULATA Linn.
26. ANTHOCEPHALUS INDICUS A. Rich. syn. A. CADAMBA Miq. (S. & H.—*Kadamba*).
27. ANTIARIS TOXICARIA Leschen.
28. ASPARAGUS ADSCENDENS Roxb. (H.—*Safed musli*; Gharwal—*Jhirna*).
29. ASPARAGUS RACEMOSUS Willd.
30. ASTERACANTHA LONGIFOLIA Nees. (H.—*Tal-makhana*; S.—*Kakil-akshya*).
31. AVERRHOA CARAMBOLA Linn. (H.—*Karmal*; M.—*Tamarta*).
32. BALANITES AEGYPTIACA Del. syn. B. ROXBURGHII Planch.
33. BARRINGTONIA ACUTANGULA (Linn.) Gaertn. (B.—*Hijal*; H.—*Hijjal*).
34. BASELLA RUBRA Linn. (S.—*Potaki*; H.—*Labachlu*).
35. BAUHINIA RACEMOSA Lam.
36. BAUHINIA TOMENTOSA Linn. (S.—*Aswamantaka*; H.—*Kachnar*; Bo.—*Asundro*; M.—*Mandarai*).
37. BAUHINIA VARIEGATA Linn.
38. BERGENIA LIGULATA (Wall.) Engl. (B.—*Patharchuri*; Bo.—*Pashanbheda*).
39. BIDENS TRIPARTITA Linn.
40. BOSWELLIA SERRATA Roxb. (S.—*Shallaki*; H. & B.—*Luban*).
41. BOTRYCHIIUM LUNARIA Sw. (English.—*Moonwort*).
42. BRASSICA CERNUA (Thunb.) Forbes & Hemsley.
43. BRUCEA AMARISSIMA (Lour.) Merr. syn. B. SUMATRANA Roxb.
- * 44. BUTEA MONOSPERMA O. Kuntze.
45. CAESALPINIA JAYABO Maza. (Arab.—*Bunduk*; Tam.—*Kalarsikkodi*).
46. CALAMUS ROTANG Linn. (S.—*Vetasa*; H., B. & Bo.—*Bet*).

47. CALOTROPIS GIGANTEA R. Br.
48. CARAPA MOLUCCENSIS Lam.
- * 49. CARUM BULBOCASTANUM Koch. (H.—*Kalajira*; Kash.—*Gunyun*).
- * 50. CARUM CARVI Linn.
51. CASSIA AURICULATA Linn. (H. & B.—*Tarwar*; Tam.—*Avaram*).
- * 52. CASSIA FISTULA Linn.
53. CASSIA TORA Linn.
54. CASSYTHA FILIFORMIS Linn.
55. CASUARINA EQUISETIFOLIA Linn. (H.—*Janglisaru*; B.—*Belatijau*).
56. CEDRELA TOONA Roxb.
57. CELSIA COROMANDELIANA Vahl. (S.—*Kulahala*; Bo.—*Kolhal*).
- * 58. CENTELLA ASIATICA (Linn.) Urban syn. HYDROCOTYLE ASIATICA Linn.
59. CEROPEGIA TUBEROSA Roxb. (P.—*Galot*; Bo.—*Khappar kadu*; M.—*Manda*).
60. CINNAMOMUM INERS Reinw. (Bo.—*Tikki*; H.—*Jangli darchini*).
61. CLITORIA TERNATEA Linn.
62. CORALLOCARPUS EPIGAEUS Benth. ex Hook. f. (S.—*Patalagaruda*).
63. CORCHORUS CAPSULARIS Linn. (S.—*Kalasaka*; H. & B.—*Narcha*).
64. CORCHORUS FASCICULARIS Lam. (B.—*Bilnalita*; Bo.—*Hirankhori*).
65. CUMINUM CYMINUM Linn.
66. CYDONIA OBLONGA Mill. syn. C. vulgaris Pers. (H.—*Bihi*; S.—*Amritphala*).
67. CYLISTA SCARIOSEA Roxb. (Bo.—*Ranghevada*).
68. CYNODON DACTYLON Pers. (H., B. & Bo.—*Dhub*).
69. CYPERUS ROTUNDUS Linn. (S. & Bo.—*Musta*; B. & H.—*Mutha*).
70. CYPERUS SCARIOSUS R. Br. (S.—*Nagar mustaka*; H. & B.—*Nagar motha*).
71. DAUCUS CAROTA Linn.
72. DESCURAINIA SOPHIA Linn. (H.—*Khubkallana*).
73. DESMODIUM GANGETICUM DC.
74. DIOSPYROS MELANOXYLON Roxb.
75. DIOSPYROS PEREGRINA Gurkein. (S.—*Tinduka*; H. & B.—*Gab*; Bo.—*Tendu*).
76. ELAEOCARPUS SERRATUS Linn. (B.—*Jalpai*; M.—*Ulang-karei*).
77. ERIGERON CANADENSIS Linn.
78. EUPHORBIA ANTIQUORUM Linn.
79. EUPHORBIA HIRTA Linn.
80. EUPHORBIA HYPERICIFOLIA Linn.
81. EUPHORBIA THYMIFOLIA Linn.
82. EVOLVULUS ALSINOIDES Linn. (S.—*Vishnugandhi*; H.—*Sankha pushpi*).
83. FAGONIA CRETICA Linn.
84. FERONIA LIMONIA (Linn.) Swingle syn. F. ELEPHANTUM Corr. (S.—*Kpittha*; H.—*Kavitha*).
85. FICUS BENGALENSIS Linn. (S.—*Vata*; H.—*Bor*; B.—*Bar*).
86. FICUS HETEROPHYLLA Linn. (S.—*Trayamana*; B.—*Bhui-dumur*).
87. FICUS HISPIDA Linn. (S.—*Kakadumbura*; H.—*Konea-dumbar*).
88. FICUS RACEMOSA Linn. syn. F. GLOMERATA Roxb. (S.—*Udumbara*; H.—*Gular*).
89. FIMBRISTYLIS JUNCIFORMIS Kunth. (Santh.—*Bindimuthi*).
90. FLEMINGIA TUBEROSA Dalz. (Bo.—*Birmova*).
- * 91. FOENICULUM CAPILLACEUM Gilb. syn. F. VULGARE Gaertn.
92. GARCINIA MANGOSTANA Linn. (H., B. & Bo.—*Mangustan*).
93. GASTROCHILUS PANDURATA Ridley.
94. GOSSYPIUM HERBACEUM Linn. (H., B. & Bo.—*Kapas*; S.—*Karpas*).
95. GREWIA HIRUSTA Vahl.
96. GREWIA MICROCOS Linn.
97. HELICTERES ISORA Linn.
- * 98. HEMIDESMUS INDICUS R. Br.
99. HIBISCUS CANNABINUS Linn. (S.—*Nali*; H.—*Patsan*; Bo.—*Ambari*).

- * 100. *HOLARRHENA ANTIDYSENTERICA* Wall.
- 101. *HOLARRHENA MITIS* R. Br. (Sinhalese—*Kiriwolla*).
- 102. *HYDROCOTYLE JAVANICA* Thunb.
- 103. *HYPERICUM JAPONICUM* Thunb.
- 104. *INDIGOFERA OBLONGIFOLIA* Forsk. (S.—*Jhilla*).
- 105. *IXORA NIGRICANS* Br. (Tam.—*Mashagani*).
- 106. *JATROPHA CURCAS* Linn.
- 107. *JATEORHIZA PALMATA* (Lam.) Miers. (Bo.—*Colombo*; Tam.—*Kolumbu*).
- 108. *JUGLANS REGIA* Linn.
- 109. *JUSSIAEA SUFRUTICOSA* Linn. (S.—*Bhulavaanga*; H.—*Banlaunga*).
- 110. *JUSTICIA GENDARUSSA* Burm. (S.—*Nila-nirgundi*; H.—*Nili-nargandi*).
- 111. *LEEA INDICA* Merrill. (H. & B.—*Kurkurjiwah*; Bo.—*Karkani*).
- 112. *LENS CULINARIS* Medic. syn. *L. ESCULENTA* Moench. (B.—*Masuri*; H. & S.—*Masur*).
- 113. *LITSEA CHINENSIS* Lam.
- 114. *LUFFA ACUTANGULA* (Linn.) Roxb. var. *AMARA* Clarke.
- 115. *MALVA ROTUNDIFOLIA* Linn. (H. & Bo.—*Khubazi*).
- 116. *MANGIFERA INDICA* Linn. (H., B. & Bo.—*Am*; S.—*Ama*).
- 117. *MELASTOMA MALABATHRICUM* Linn. (Burma.—*Myetpye*; Tel.—*Pattudu*).
- 118. *MENTHA LONGIFOLIA* Huds. syn. *M. SYLVESTRIS* Linn. (B., H. & S.—*Pudina*).
- 119. *MESUA FERREA* Linn. (S., H. & B.—*Nagkeshar*; Bo.—*Nagchampa*).
- 120. *MIMOSA PUDICA* Linn. (S.—*Lajja*; H. & Bo.—*Lajalu*).
- 121. *MIMUSOPS ELENGI* Linn. (S., H. & B.—*Bakul*; Bo.—*Borsali*).
- 122. *MORINDA CITRIFOLIA* Linn. (H. & B.—*Ach*; Bo.—*Aal*).
- 123. *MORINDA UMBELLATA* Linn. (Bo.—*Al*; S.—*Pitadaru*).
- 124. *MUSA SAPIENTUM* O. Kuntze.
- 125. *MUCUNA PRURITA* Hook. (S.—*Atmagupta*; H. & P.—*Kawanch*).
- 126. *MURRAYA KOENIGII* Spreng. (S.—*Sourabhi-nimba*; H.—*Katnim*).
- 127. *MURRAYA PANICULATA* Jack. (H.—*Marchula*; B.—*Kamini*).
- 128. *MYRICA NAGI* Thunb. (S.—*Katphala*; H., B. & Bo.—*Kaiphai*).
- 129. *MYRTUS COMMUNIS* Linn. (H.—*Vilayiti mehdi*; B.—*Sutr-sowa*).
- 130. *NANNORHOPS RITCHIEANA* H. Wendl. (H.—*Mazri*).
- 131. *NEPETA ELLIPTICA* Royle ex Benth. (P.—*Tukhmmalanga*).
- 132. *NYMPHAEA ALBA* Linn. (Kash.—*Brimposh*; Bo.—*Pandharen-kamal*).
- 133. *NYMPHAEA PUBESCENS* Willd. (M.—*Alli*).
- 134. *OCIMUM AMERICANUM* Linn. syn. *O. CANUM* Sims. (H. & B.—*Kala tulshi*).
- 135. *OCIMUM BASILICUM* Linn. (S.—*Munjariki*).
- 136. *OLDENLANDIA AURICULARIA* K. Schum. (B.—*Muttialata*; Bo.—*Dapoli*).
- 137. *OROXylum INDICUM* Vent. (S.—*Syonaka*; H.—*Arlu*; B.—*Sona*).
- 138. *OXALIS CORNICULATA* Linn. (S.—*Amlika*; H. & B.—*Amrul*).
- 139. *PAVONIA ODORATA* Willd. (S.—*Harivera*; B.—*Bala*; Bo.—*Kala vala*).
- * 140. *PEUCEDANUM GRAVEOLENS* Benth.
- 141. *PHASEOLUS TRILOBUS* Ait.
- * 142. *PHYLLANTHUS EMBLICA* Linn. (S.—*Dhatrithala*; H.—*Aoula*; Bo.—*Amla*).
- * 143. *PHYLLANTHUS NIRURI* Linn. (S.—*Bhumyamalaki*; H.—*Jar-amlu*).
- 144. *PHYLLANTHUS URINARIA* Linn.
- 145. *PIPER LONGUM* Linn.
- * 146. *PIPER NIGRUM* Linn. (S.—*Maricha*; H.—*Golmirch*; B.—*Golmarich*).
- * 147. *PISTACIA INTEGERRIMA* Stew.
- 148. *PISTIA STRATIOTES* Linn.
- * 149. *PLANTAGO CILIATA* Desf.
- 150. *PLANTAGO MAJOR* Linn.
- 151. *PLANTAGO OVATA* Forsk.
- * 152. *PLATANUS ORIENTALIS* Linn. (P. & Kash.—*Buin*).

153. PLUMBAGO ZEYLANICA Linn.
154. PSIDIUM GUAJAVA Linn.
155. PULICARIA DYSENTERICA Gaertn.
156. PUNICA GRANATUM Linn. (S.—*Darimba*; H.—*Anar*).
157. RHEUM EMODI Wall.
158. RUBIA CORDIFOLIA Linn. (S. & B.—*Manjistha*; H.—*Manjith*; Bo.—*Manjit*).
159. RUMEX SCUTATUS Linn. (English.—*French sorrel*).
160. RUMEX VASICARIUS Linn. (S.—*Chukra*; H., B. & Bo.—*Chuka*).
161. SALIX ALBA Linn. (P.—*Bis*; Kash.—*Vuir*).
162. SAPINDUS TRIFOLIATUS Linn.
163. SARACA INDICA Linn.
164. SCINDAPSUS OFFICINALIS Schott. (H. & B.—*Gajapipal*; Bo.—*Thora-pimble*).
165. SEMECARPUS ANACARDIUM Linn. f.
166. SHOREA ROBUSTA Gaertn. f. (S.—*Sala*; H., B., P. & Bo.—*Sal*).
167. SIDA SPINOSA Linn. (S.—*Nagabala*; H.—*Gulsakari*; B.—*Bonmethi*).
168. SMILAX PROLIFERA Roxb. (H.—*Ram dataun*).
169. SOLANUM NIGRUM Linn. (S. & B.—*Kakmachi*; Bo.—*Makao*).
170. SOYMIDA FEBRIFUGA A. Juss. (S.—*Rohuma*; H., B. & Bo.—*Rohan*).
171. SPILANTHES ACMEILLA Murr. (Bo. & P.—*Akarkara*).
172. STACHYTARPHETA JAMAICENSIS Vahl. var. INDICA Lam. syn. S. INDICA Vahl. (M.—*Simainayuruvi*).
173. STRYCHNOS NUX-VOMICA Linn.
174. SYMPLOCOS RACEMOSA Roxb.
175. SYZYGIUM CUMINI (Linn.) Skeels syn. EUGENIA JAMBOLANA Lam. (S. & B.—*Jambu*; H.—*Jamun*; B.—*Jam*).
176. SYZYGIUM JAMBOS (Linn.) Alst. syn. EUGENIA JAMBOS Linn. (S.—*Jambu*; H. & Bo.—*Gulabjaman*).
177. SYZYGIUM OPERCULATUM Gamble. syn. EUGENIA OPERCULATA Roxb. (H.—*Rai-jaman*; S.—*Bhumi-jambu*).
178. TECTONA GRANDIS Linn. f. (S.—*Saka*; H. & B.—*Segun*).
- * 179. TERMINALIA ARJUNA W. & A.
- * 180. TERMINALIA CHEBULA Retz.
181. TERMINALIA CITRINA Roxb.
182. TRIUMFETTA BARTRAMIA Linn. (H.—*Chikti*; B.—*Bunokra*).
- * 183. TYLOPHORA ASTHMATICA W. & A.
184. TYPHA ELEPHANTINA Roxb. (B.—*Hogla*; Bo.—*Ramban*; Kash.—*Pitz*).
185. URARIA LAGOPOIDES DC. (Bo.—*Dowla*; H.—*Pithvan*).
186. VATERIA INDICA Linn.
187. WOODFORDIA FRUTICOSA Kurz. (S.—*Dhataki*; H. & B.—*Dhai*).
188. WRIGHTIA TINCTORIA R. Br. (S.—*Svetakutaja*; H.—*Mitha indarjou*; B.—*Indrajau*).

E. PLANT REMEDIES USED IN SNAKE-BITE

A large number of medicinal plants have been used in the treatment of snake-bites in Indian indigenous medicine. With a view to find out whether the exaggerated claims put forward on their behalf have any basis of truth, Caius and Mhaskar (Indian Medical Research Memoirs No. 19, January, 1931) have carried out extensive pharmacological and toxicological investigations on animals. Healthy dogs weighing from 6 to 10 kilos were injected sub-cutaneously with both Cobra and Daboia venoms and the antidotal effects of the various remedies on such animals were noted. The remedies were administered in strict conformity

with the directions laid down in the standard books of Indian medicine. The samples used in these experiments were all obtained fresh from the garden or the bazar. For internal administration, a concentrated watery extract of the powdered plant was used. For external application, the concentrated watery solution was instilled by means of a pipette into the eyes or nostrils of experimental animals. Sometimes the finely ground powder was rubbed directly over the site of inoculation of the venom. The dosage indicated in the literature was adhered to by these workers as far as possible. A list of the plant remedies experimented upon is given below. The opinion of these workers is that none of the following Indian plants recommended for the treatment of snake-bite has any preventive, antidotal or therapeutic effect:

Abrus precatorius Linn., *Acacia concinna* DC., *Acacia farnesiana* Willd., *Acacia pennata* Willd., *Acalypha indica* Linn., *Acanthus ilicifolius* Linn., *Achyranthes aspera* Linn., *Aconitum ferox* Wall., *Aconitum heterophyllum* Wall., *Acorus calamus* Linn., *Actaea spicata* Linn., *Adhatoda vasica* Ness., *Aegle marmelos* Correa., *Alanthus malabarica* D.C., *Alangium lamarckii* Thw., *Albizia lebbek* Benth., *Allium sativum* Linn., *Alstonia scholaris* R. Br., *Alternanthera sessilis* Br., *Althaea officinalis* Linn., *Althaea rosea* Linn., *Amarantus spinosus* Linn., *Amarantus tristis* Linn., *Amarantus viridis* Linn., *Amomum subulatum* Roxb., *Anacardium occidentale* Linn., *Anagallis arvensis* Linn., *Anamirta cocculus* W. & A., *Andropogon muricatus* Retz., *Andropogon schoenanthus* Linn., *Aneilema scapiflorum* Wight., *Anisomeles malabarica* R. Br., *Anogeissus latifolia* Wall., *Anthocephalus cadamba* Mig., *Antidesma bunias* Muell.Arg., *Aquilaria agallocha* Roxb., *Areca catechu* Linn., *Argemone maxicana* Linn., *Arisaema speciosum* Mart., *Aristolochia bracteata* Retz., *Aristolochia indica* Linn., *Aristolochia longa* Linn., *Aristolochia serpentaria* Linn., *Artemisia maritima* Linn., *Artemisia vulgaris* Linn., *Arthrocnemum indicum* Moq., *Artocarpus integrifolia* Linn., *Asparagus racemosus* Willd., *Atalantia monophylla* Correa., *Balanites roxburghii* Planch., *Baliospermum axillare* Blume., *Balsamodendron roxburghii* Arn., *Bambusa arundinacea* Retz., *Barleria cristata* Linn., *Barringtonia acutangula* Gaertn., *Bassia longifolia* Willd., *Bauhinia tomentosa* Linn., *Bauhinia variegata* Linn., *Benincasa cerifera* Savi., *Berberis asiatica* Roxb., *Betula bhojpattra* Wall., *Bixa orellana* Linn., *Boerhaavia diffusa* Linn., *Bombax malabriculum* DC., *Boswellia serrata* Roxb., *Bragantia wallichii* R. Br., *Brassica campestris* Linn., *Brassica nigra* Koch., *Butea frondosa* Roxb., *Butea superba* Roxb., *Caesalpinia bonducella* Fleming., *Cajanus indicus* Spreng., *Calamus rotang* Linn., *Calotropis gigantea* R. Br., *Calycopteris floribunda* Lamk., *Capsicum annuum* Linn., *Cardiospermum halicacabum* Linn., *Careya arborea* Roxb., *Carum copticum* B. & H., *Caryophyllus aromaticus* Linn., *Cassia alata* Linn., *Cassia fistula* Linn., *Cassia occidentalis* Linn., *Cassia sophera* Linn., *Cassia tora* Linn., *Cedrus deodara* Loudon., *Celastrus senegalensis* Lamk., *Cephalandra indica* Naud., *Cicer arietinum* Linn., *Cinnamomum tamala* Nees., *Cinnamomum zeylanicum* Breyn., *Cissampelos pareira* Linn., *Citrullus colocynthis* Schrad., *Citrus medica* Linn., *Clematis triloba* Heyne., *Cleome viscosa* Linn., *Clerodendron infortunatum* Gaertn., *Clerodendron serratum* Spreng., *Clitoria ternatea* Linn., *Cocos nucifera* Linn., *Coix lachryma* Linn., *Commelina obliqua* Ham., *Coralocarpus epigaues* Hook. f., *Cordia obliqua* Willd., *Coriandrum sativum* Linn., *Coscinium fenestratum* Colebr., *Costus speciosus* Smith., *Crataeva religiosa* Forst., *Crocus sativus* Linn., *Croton oblongifolius* Roxb., *Croton tiglium* Linn., *Cucumis trigonus* Roxb., *Cuminum cyminum* Linn., *Curcuma aromatica* Salisb., *Curcuma longa* Linn., *Cyclamen persicum* Miller., *Cynodon dactylon* Pers., *Cyperus rotundus* Linn., *Daemia extensa* R.Br., *Datura fastuosa* Linn., *Dendrobium macraei* Lindl., *Derris scandens* Benth., *Desmodium gangeticum* DC., *Dioscorea oppositifolia* Linn., *Diospyros embryopteris* Pers., *Doronicum pardalianches* Linn., *Elaeodendron glaucum* Pers., *Elephantopus scaber* Linn., *Elettaria cardamomum* Maton., *Embelia ribes* Burm., *Ervum lens* Linn., *Erythrina indica* Lam., *Eupatorium ayapana* Vent., *Euphorbia antiquorum* Linn., *Euphorbia nerifolia* Linn., *Euphorbia thymifolia* Burm., *Fagonia arabica* Linn., *Feronia elephantum* Correa., *Ferula*

foetida Regel, *Ficus bengalensis* Linn., *Ficus carica* Linn., *Ficus glometara* Roxb., *Ficus religiosa* Linn., *Ficus rumphii* Blume., *Flacourtia sepiaria* Roxb., *Flueggia microcarpa* Blume., *Foeniculum vulgare* Gaertn., *Gloriosa superba* Linn., *Glossogyne pinnatifida* DC., *Glycosmis pentaphylla* Correa., *Glycyrrhiza glabra* Boiss., *Gmelina arborea* Linn., *Gossypium herbaceum* Linn., *Gymnema sylvestre* Br., *Gynandropsis pentaphylla* DC., *Hedychium spicatum* Ham., *Helianthus annuus* Linn., *Helicteres isora* Linn., *Heliotropium eichwaldi* Steud., *Heliotropium indicum* Linn., *Heliotropium strigosum* Willd., *Heliotropium undulatum* Vahl., *Hemidesmus indicus* R.Br., *Herpestis monniera* H. B. & K., *Heterophragma roxburghii* DC., *Hibiscus abelmoschus* Linn., *Holarrhena antidysenterica* Wall., *Hugonia mystax* Linn., *Hydrocotyle asiatica* Linn., *Ichmocarpus frutescens* Br., *Indigofera tinctoria* Linn., *Iodidium suffruticosum* Ging., *Ipomoea biloba* Forsk., *Ipomoea bona-nox* Linn., *Ipomoea campanulata* Linn., *Ipomoea digitata* Linn., *Ipomoea turpethum* Br., *Jasminum grandiflorum* Linn., *Jasminum pubescens* Willd., *Killinga monocephala* Linn., *Lantana indica* Roxb., *Leucas aspera* Spreng., *Leucas linifolia* Spreng., *Leucas zeylanica* Br., *Limonia acidissima* Linn., *Liquidambar orientalis* Miller., *Litsea sebifera* Pers., *Lobelia nicotianaefolia* Heyne., *Luffa acutangula* Roxb., *Luffa echinata* Roxb., *Luvunga scandens* Ham., *Mallotus philippinensis* Muell. Arg., *Mangifera indica* Linn., *Matthiola incana* R.Br., *Melia azadirachta* Linn., *Mesua ferrea* Linn., *Michelia champaca* Linn., *Mimosa pudica* Linn., *Mimusops elengi* Linn., *Momordica charantia* Linn., *Momordica dioica* Roxb., *Moringa pterygosperma* Gaertn., *Mucuna pruriens* DC., *Murraya koenigii* Spreng., *Musa sapientum* Linn., *Myrica nagi* Thumb., *Myristica fragrans* Houtt., *Nardostachys jatamansi* DC., *Nelumbium speciosum* Willd., *Nerium odorum* Soland., *Nigella sativa* Linn., *Nyctanthes arborescens* Linn., *Ocimum basilicum* Linn., *Ocimum gratissimum* Linn., *Ocimum sanctum* Linn., *Oldenlandia umbellata* Lin., *Ophiorrhiza mungos* Linn., *Opuntia dillenii* Haw., *Oroxylum indicum* Vent., *Papaver somniferum* Linn., *Paramignya monophylla* Wight., *Parmelia perlata* Esch., *Pentapetes phoenicea* Linn., *Pericampylus incanus* Miers., *Peristrophe bicalyculata* Nees., *Phaseolus mungo* Linn., *Phaseolus trilobus* Ait., *Phyllanthus distichus* Muell. Arg., *Phyllanthus emblica* Linn., *Phyllanthus niruri* Linn., *Physalis minima* Linn., *Picrorrhiza kurroo* Benth., *Pinus longifolia* Roxb., *Piper betle* Linn., *Piper longum* Linn., *Piper nigrum* Linn., *Piper sylvaticum* Roxb., *Pistacia integerrima* Stewart., *Pittosporum floribundum* W. & A., *Plantago amplexicaulis* Cav., *Plumbago rosea* Linn., *Plumeria acutifolia* Poir., *Pogostemon parviflorus* Benth., *Polycarpaea corymbosa* Lamk., *Polygala crotalarioides* Ham., *Pongamia glabra* Vent., *Pothos scandens* Linn., *Premna herbacea* Roxb., *Prosopis spicigera* Linn., *Prunus mahaleb* Linn., *Prunus puddum* Roxb., *Psoralea corylifolia* Linn., *Pterocarpus santalinus* Linn., *Punica granatum* Linn., *Putranjiva roxburghii* Wall., *Randia dumetorum* Lamk., *Rauwolfia serpentina* Benth., *Rhinacanthus communis* Nees., *Ricinus communis* Linn., *Rubia cordifolia* Linn., *Rumex vesicarius* Linn., *Rungia repens* Nees., *Saccharum officinarum* Linn., *Salvadora oleoides* Dcne., *Salvadora persica* Linn., *Sansevieria zeylanica* Willd., *Santalum album* Linn., *Sapindus trifolius* Linn., *Saraca indica* Linn., *Saussurea lappa* Clarke., *Schleichera trijuga* Willd., *Scindapsus pertusus* Schott., *Semecarpus anacardium* Linn., *Sesamum indicum* DC., *Sesbania grandiflora* Pers., *Shorea robusta* Gaertn., *Sida carpinifolia* Linn., *Sida rhombifolia* Linn., *Solanum indicum* Linn., *Solanum nigrum* Linn., *Solanum xanthocarpum* S. & W., *Spondias mangifera* Willd., *Stereospermum chelonoides* DC., *Streblus asper* Lour., *Strychnos colubrina* Linn., *Strychnos nux-vomica* Linn., *Strychnos potatorum* Linn., *Symplocos racemosa* Roxb., *Tabernaemontana dichotoma* Roxb., *Taxus baccata* Linn., *Tectona grandis* Linn., *Terminalia arjuna* W. & A., *Terminalia belerica* Roxb., *Terminalia chebula* Retz., *Terminalia tomentosa* W. & A., *Tiliacora racemosa* Coleb., *Tinospora cordifolia* Miers., *Trachylobium hornemannianum* Heyne., *Trapa bispinosa* Roxb., *Trichodesma indicum* Br., *Trichosanthes dioica* Roxb., *Typhonium trilobatum* Schott., *Uaria lagopoides* D.C., *Uaria picta* Desv., *Valeriana wallichii* DC., *Vanda roxburghii* R.Br., *Vangueria spinosa* Roxb., *Vateria indica* Linn., *Verbena officinalis* Linn., *Vernonia anthelmintica* Willd., *Vitex agnus-castus* Linn., *Vitex negundo* Linn., *Vitis vinifera* Linn., *Withania somnifera* Dunal., *Woodfordia floribunda* Salisb., *Wrightia tomentosa* Roem. & Schud., *Xanthium strumarium* Linn., *Zanthoxylum alatum* Roxb., *Zingiber cassumunar* Roxb., *Zingiber officinale* Roscoe.

F. PLANT REMEDIES USED IN SCORPION-STING

Caius and Mhaskar (Indian Medical Research Memoirs No. 24, June, 1932), have recently carried out a detailed investigation into the action of the venom of Indian scorpions by modern physiological methods. The treatment of scorpion-stings by medicinal plants, indigenous or imported, used in India has also been referred to. As the subject is likely to be of interest to the readers of this book, a summary of the important findings and the main conclusions is given below.

The scorpions more commonly met with in India belong to either genus *Buthus* or *Palamnoeus*, the *Buthus* variety being more poisonous. Contrary to popular belief, scorpion-sting has been found to be very rarely fatal to human beings. Different animals, however, exhibit different degrees of resistance to the action of the venom. Scorpion venom resembles snake venom in many of its characteristics. The following active principles have been isolated from it: (1) Neurotoxins which act principally on the vasomotor and respiratory centres and on the nerve-endings in striated and unstriated muscles, (2) haemolysins, agglutinins, haemorrhagins, leucocytolysins, coagulants, ferments, lecithin and cholesterolin, (3) a cardiac tonic principle and (4) a vascular tonic principle.

PHARMACOLOGICAL ACTION.—Scorpion venom when injected into the skin causes intense local irritation due to stimulation of the terminations of the sensory nerves of the skin. When it is injected into the blood stream, the vasomotor and respiratory centres are stimulated leading to a rise of blood pressure and an increase of the respiratory excursions. Excessive lachrymal, nasal and salivary secretions are also noticed owing to stimulation of the facial nerve centres. Spasmodic contraction of the musculature of the intestine and urinary bladder is evident. On the smooth muscle, the venom appears to act like the pilocarpine group of drugs by stimulating the nerve endings of the parasympathetic system. The heart is definitely stimulated and continues to beat even after the paralysis of the respiratory centre. The nervous system is generally excited. Reflexes are increased as evidenced by shivering, tremor and muscular twitchings. Sometimes strychnine-like convulsions are noticed. Later paresis or paralysis of muscles occur, due to the affection of the motor nerve endings. Death in experimental animals is always due to direct paralytic action of the venom on the respiratory centre.

TREATMENT OF SCORPION-STINGS.—The antivenom prepared at Kasauli against cobra and dabioa venoms imparts a certain amount of protection to rabbits and dogs receiving lethal doses of the scorpion venom. A large number of indigenous remedies from the vegetable kingdom has been tried. None of the Indian remedies popularly used has been found to have any preventive, antidotal or therapeutic effect. The list of such drugs is given below.

Achyranthes aspera Linn., *Aconitum ferox* Wall., *Aconitum heterophyllum* Wall., *Acorus calamus* Linn., *Adiantum venustum* Don., *Albizia lebbek* Benth., *Allium cepa* Linn., *Alocasia macrorrhiza* Schott., *Alstonia scholaris* R. Br., *Amarantus viridis* Linn., *Amomum subulatum* Roxb., *Andropogon muricatus* Retz., *Andropogon schoenanthus* Linn., *Anisomeles malabarica* R. Br., *Anogeissus latifolia* Wall., *Aquilaria agallocha* Roxb., *Areca catechu* Linn., *Aristol-*

chia indica Linn., *Artemisia maritima* Linn., *Artemisia vulgaris* Linn., *Arthrocnemum indicum* Moq., *Artocarpus integrifolia* Linn., *Asparagus racemosus* Willd., *Baliospermum axillare* Blume, *Balsamodendron roxburghii* Arn., *Bambusa arundinacea* Retz., *Barleria cristata* Linn., *Bassia longifolia* Willd., *Bauhinia tomentosa* Linn., *Berberis asiatica* Roxb., *Boerhaavia diffusa* Linn., *Bombax malabaricum* DC., *Borassus flabelliformis* Linn., *Boswellia serrata* Roxb., *Brassica nigra* Koch., *Butea frondosa* Roxb., *Butea superba* Roxb., *Calamus rotang* Linn., *Calotropis gigantea* R. Br., *Cardiospermum halicacabum* Linn., *Careya arborea* Roxb., *Carthamus tinctorius* Linn., *Carum copticum* B. & H., *Cassia alata* Linn., *Cassia fistula* Linn., *Cassia sophera* Linn., *Cassia tora* Linn., *Cedrus deodara* Loudon., *Cephalandra indica* Naud., *Ceratophyllum demersum* Linn., *Cinnamomum tamala* Nees., *Cinnamomum zeylanicum* Breyn., *Cissampelos pareira* Linn., *Citrullus colocynthis* Schrad., *Citrus medica* Linn., *Clerodendron infortunatum* Gaertn., *Clerodendron serratum* Spreng., *Clitoria ternatea* Linn., *Colocasia antiquorum* Schott., *Cordia obliqua* Willd., *Coriandrum sativum* Linn., *Crataeva religiosa* Forst., *Crocus sativus* Linn., *Croton tiglium* Linn., *Cucurbita maxima* Duch., *Cuminum cyminum* Linn., *Curcuma longa* Linn., *Curcuma zedoaria* Roscoe, *Cynodon dactylon* Pers., *Cyperus rotundus* Linn., *Datura fastuosa* Linn., *Dendrobium macraei* Lindl., *Desmodium gangeticum* DC., *Dioscorea oppositifolia* Linn., *Eclipta alba* Hassk., *Elettaria cardamomum* Maton., *Embelia ribes* Burm., *Eriodendron anfractuosum* DC., *Euphorbia nerifolia* Linn., *Feronia elephantum* Correa, *Ferula foetida* Regel., *Ficus glomerata* Roxb., *Gloriosa superba* Linn., *Glossogyne pinnatifida* DC., *Glycyrrhiza glabra* Boiss., *Gmelina arborea* Linn., *Gossypium herbaceum* Linn., *Gynandropsis pentaphylla* DC., *Helianthus annuus* Linn., *Heliotropium cichwaldi* Steud., *Heliotropium indicum* Linn., *Hemidesmus indicus* R. Br., *Holarrhena antidysenterica* Wall., *Ichnocarpus frutescens* Br., *Indigofera tinctoria* Linn., *Ionidium suffruticosum* Ging., *Ipomoea digitata* Linn., *Ipomoea turpethum* Br., *Jasminum grandiflorum* Linn., *Justicia picta* Roxb., *Killingia monocephala* Linn., *Lagenaria vulgaris* Seringe., *Leucas cephalotes* Spreng., *Liquidambar orientalis* Miller., *Litsea sebifera* Pers., *Lobelia nicotianaeifolia* Heyne., *Luvunga scandens* Ham., *Mangifera indica* Linn., *Martynia diandra* Glox., *Melia azadirachta* Linn., *Mesua ferrea* Linn., *Michelia champaca* Linn., *Mimosa pudica* Linn., *Momordica dioica* Roxb., *Moringa pterygosperma* Gaertn., *Mucuna pruriens* D.C., *Myrtus communis* Linn., *Nardostachys jatamansi* DC., *Nelumbium speciosum* Willd., *Nicotiana tabacum* Linn., *Nigella sativa* Linn., *Ocimum basilicum* Linn., *Ocimum sanctum* Linn., *Ophiorrhiza mungos* Linn., *Oroxylum indicum* Vent., *Papaver somniferum* Linn., *Parmelia perlata* Esch., *Paspalum scrobiculatum* Linn., *Phaseolus mungo* Linn., *Phaseolus trilobus* Ait., *Phyllanthus emblica* Linn., *Physalis minima* Linn., *Picrorhiza kurrooa* Benth., *Pinus longifolia* Roxb., *Piper longum* Linn., *Piper nigrum* Linn., *Pistacia integerrima* Stewart., *Plumbago rosea* Linn., *Pogostemon parviflorus* Benth., *Pongamia glabra* Vent., *Premna herbacea* Roxb., *Prosopis spicigera* Linn., *Prunus mahaleb* Linn., *Prunus puddum* Roxb., *Psoralea corylifolia* Linn., *Pterocarpus santalinus* Linn., *Punica granatum* Linn., *Randia dumetorum* Lamk., *Rauvolfia serpentina* Benth., *Ricinus communis* Linn., *Rubia cordifolia* Linn., *Rumex vesicarius* Linn., *Ruta graveolens* Linn., *Santalum album* Linn., *Sapindus trifoliatus* Linn., *Saraca indica* Linn., *Saussurea lappa* Clarke, *Scindapsus pertusus* Schott., *Semecarpus anacardium* Linn., *Sesamum indicum* DC., *Shorea robusta* Gaertn., *Sida carpinifolia* Linn., *Sida rhombifolia* Linn., *Solanum indicum* Linn., *Solanum nigrum* Linn., *Stereospermum chelonoides* DC., *Swertia chirata* Ham., *Symplocos racemosa* Roxb., *Tabernaemontana dichotoma* Roxb., *Tamarindus indica* Linn., *Taxus baccata* Linn., *Terminalia arjuna* W. & A., *Terminalia belerica* Roxb., *Terminalia chebula* Retz., *Tinospora cordifolia* Miers., *Trachylobium hornemannianum* Heyne., *Tragia involucrata* Linn., *Trapa bispinosa* Roxb., *Trianthema pentandra* Linn., *Tribulus terrestris* Linn., *Trichosanthes dioica* Roxb., *Uraria lagopoides* DC., *Valeriana wallichii* DC., *Vanda roxburghii* R. Br., *Vangueria spinosa* Roxb., *Vernonia anthelmintica* Willd., *Vernonia cinerea* Less., *Vitex agnus-castus* Linn., *Vitex negundo* Linn., *Vitis vinifera* Linn., *Withania somnifera* Dunal., *Wrightia tomentosa* Rom. & Schult., *Xanthium strumarium* Linn., *Zingiber officinale* Roscoe., *Zizyphus jujuba* Lamk.

SECTION IV

A. AROMATIC OR ESSENTIAL OIL BEARING PLANTS

Introduction

Natural perfume is one of the most remarkable phenomenon of plant metabolism and the history of aromatic plants is perhaps the most romantic story of any vegetable product. Man has always tried increasingly to utilize these odoriferous plants for his pleasure and well-being. From ancient times spices derived from aromatic plants have been used as flavouring agents for food and drinks. Their use as offering to deities, as incense, in medicine, for aesthetic purposes, as principal agents for embalming the dead, for preventing insects from damaging fabrics and grain has been in vogue from times immemorial. From the early times particularly during Greek and Roman periods a large trade flourished between India and the West and even now some of the Indian aromatic plant products are greatly valued. The aroma of a plant or any of its parts may be due to the essential oil which sometimes exists in a free state as in the case of rose flowers, or occasionally in the form of a glycoside which may be decomposed by an enzyme present along with it, as in bitter almonds. The whole of the plant may be odoriferous or the odour may reside in one or more of its parts, viz. flower, leaf, bark, wood, root or rhizome, fruit, seed, or even gum or oleoresin may be aromatic. Most edible fruits have a pleasant flavour which is due to the presence of aromatic substances in them. The essential oils are formed in special cells, glands or ducts (i.e. oil ducts or vitae of Umbelliferous fruits) either in one particular organ or distributed in many parts of the plant.

The essential oils occurring in aromatic plants which constitute an important group in Indian flora, play quite a significant role in the economy of man. These differ from the vegetable or fixed oils in being volatile and for this reason the name volatile is given to them. The essential oils in plants, as a rule are present in small quantities. In cloves as much as 16 to 18 per cent. is present while in rose flower as little as 0.02 per cent. and in jasmine one tenth of this quantity is obtained, from flowers locally grown. Chemically the essential oils are a combination of substances such as terpenes, sesquiterpenes, phenols, alcohols, acids, esters, aldehydes, ketones, nitrogen and sulphur compounds, whereas the vegetable or fixed oils are chiefly chemical combinations of glycerine and various acids. The function of these odoriferous bodies in the different parts of the plant is not well understood and different views have been advanced. The fragrant odour in the unfertilised flowers attracts the insects with fecundating pollen and thus helps in the cross pollination. The presence of volatile oils in the bark may have certain protective value especially against the attacks of insects. Another view advanced is that they regulate the rate of transpiration in plants. In cases where secretion or excretion of the essential oil takes place near the surface of an

organ, moisture which is saturated with essential oil has a different heat conductivity from that of moisture by itself so that a plant which gives off much perfume may be protected during the day from too great transpiration and during the night from too great reduction of temperature. The high rate of consumption of essential oil during fecundation, points to a distinct nutritive value, possibly due to easy assimilation owing to the chemical constitution of the essential oil. As a matter of fact the majority of essential oils are the bye-products of the metabolic process of cell life in the same way as are many of the alkaloids, colouring matters, tannins, etc. In certain cases it is possible they may possess excretionary functions.

The application of essential oils in day to day field of human activities is very extensive. A few of the common uses to which essential oils and their derivatives are put to are: The manufacture of soap, cosmetics, pharmaceutical preparations, confectionery, aerated waters, disinfectants and detergents, tobacco, incenses, etc. India was reputed for the manufacture and distillation of high quality of different 'attars', scents and essential oils and a considerable and profitable trade existed in the past with countries in the West.

The people of India have been known from times immemorial to be fond of rich perfumes for their personal pleasures and also in the performances of some of their religious ceremonies. Earliest records of history show that sandal wood was held in great reverence in all religious ceremonies in India and that it constituted an article of barter between Indian and the Mediterranean countries, thousands of years ago. Mention of the Indian perfumery industry is also found in Sanskrit, Pali and Islamic literature. The Moghul Emperors of India were great patrons of the perfumes of India and Abul Fazl in the *Ain-i-Akbari* says "His Majesty is very fond of perfumes. The courtwall is continually scented with ambergris, aloe, and compositions according to ancient recipes or mixtures invented by His Majesty; the incense is daily burnt in gold and silver censers of various shapes, while sweet smelling flowers are used in large quantities". Queen Elizabeth is also reported to have used Indian perfumes while Mary Queen of Scots used to get her baths delicately perfumed with these scents. India is fortunate in having a variety of climatic and altitudinal conditions and different soils suitable for the growth of a large variety of aromatic plants. Obviously the variety of indigenous raw materials for the growth of essential oil industry also is very large. Besides the raw material available in nature, a large number of exotic aromatic plants can also be cultivated for which suitable cultural conditions are found in this vast sub-continent.

According to Sadgopal, raw materials from 1,000 different aromatic plants out of a total of about 1,500 varieties used in perfumery throughout the world are found in India. A tentative list of plant families with their aromatic members and their distribution in India has been recorded by him and is reproduced here. This list is by no means exhaustive as it does not include the plants that are introduced for cultivation for producing essential oils.

Plant Families with their Aromatic Members and their Distribution in India

No.	FAMILY	AROMATIC MEMBERS	OCCURRENCE
1.	CONIFERAE	Indian silver fir, Himalayan deodar, Indian blue pine, Chir pine, <i>Callitris rhomoboides</i> , <i>Pinus khasia</i> , <i>Pinus merkusii</i> .	N.-W. Himalayan Range, Assam, Nainital, Mussoorie, Kumaon, Almora, Nurpur-Kangra, Bhutan, Shivalik Hills, Chittagong & Khasia Hills, Nilgris.
2.	CUPERESSINEAE	Cedar leaf and Cedar wood.	Malabar, tropical forests from Sikkim to Chittagong and Konkan to Mysore.
3.	ERICACEAE	Winter green, <i>Gaultheria leucocarpa</i> , <i>G. procumbens</i> , <i>G. punctata</i> , Marsh Tea.	Kashmir, Nepal, Bhutan, Madras & Nilgiri Hills.
4.	GRAMINEAE	Appagrass, Bamber grass, Botha grass, Bode grass, Camel grass, Citronella, Cochin grass, Delft grass, Ginger grass, Inchi grass, Kachi grass, Kamakshi grass, Lemon grass, Palmarosa, Vetiver, <i>Andropogon intermedius</i> , <i>Cymbopogon coloratus</i> , <i>C. confertiflorus</i> , <i>C. isvarn-cussa</i> .	Travancore, Gorakhpur, Malabar, Bahraich, Mysore, N. W. of Baluchistan and Punjab, Bikaner, W. Indian Coast, Assam, Nimaaur, Gaumghat, Hoshangabad, Seor, Mandala, Khandedh, Pimepner, Nandarbar, Shahada, Taloda, Ellichpur, Muktagiri, Sinnar & Kawan Ranges of Nasik, N. Karnet, Kashmir, Simla Hills, Almora, Garhwar, Santhal Parganas, N. Arcot, Cochin, Tinnexelly, Ajango, Periyor, Nailam Patty, Jalpaiguri Distt., Rajpur, Dhar Panchmah Melghat, Tuticoran, Bharatpur, Musanagar, Poona, Than Sindh, Anamalak, Sawantwadi, Chanda, Cormondal, Chhonagour, Mathura, Kurukst, Haridwar, Multan.
5.	LABIATAE	Basil, Thyme, Patchouli, Mint, Hyssop, Lavender, Melissa, Rosemary, <i>Perovskia artoplifolia</i> .	Kashmir, Gangetic plains, Kumaon, Assam Konkan, Western & Central India, Berar & Coimbatore.
6.	LAURACEAE	Bellary-leaf, Bois-de Rose, Camphor, Cassia, Cinnamon, Cinnamon leaf <i>C. glanduliferum</i> , <i>C. tamala</i> , <i>C. iners</i> , Sassafras, Sassafras leaf.	Kashmir, North-East Frontiers, Nepal, Western Bengal, U. P., Orissa, Mysore, Malabar and Konkan.
7.	MAGNOLIACEAE	Champaca-flower, Champaca-leaf and Star-anise.	Northern India, Kumaon, Assam, Nepal, Bengal, Orissa, Sindh, Nilgiris, Travancore, Malabar & Ganjam Dist.
8.	MYRISTICACEAE	Nutmeg.	Malabar and Ceylon.
9.	MYRTACEAE	Cajuput, Clove, Clove-leaf, Clove roots, Clove stems, Eucalyptus, Myrtle, <i>Eugenia jambolana</i> .	Kapurthala, Lahore, Simla, Hills, Himalayan valley, Nilgiris, Malabar and India.

No.	FAMILY	AROMATIC MEMBERS	OCCURRENCE
10.	PANDANACEAE	Kewda.	Central India (Dhar.), South India, Uttar Pradesh, Ganjam Distt.
11.	RUTACEAE	Bergamot, Citron, Lemon, Lime, Mandarin, <i>Murraya exotica</i> , <i>M. koenigii</i> , Neroli, Bitter Orange, Sweet Orange, Petitgrain rue, <i>Skimmia laureola</i> , <i>Xanthoxylum budrunga</i> , <i>X. ovalifoium</i> , <i>X. rhetsa</i> .	Himalayan valleys, West-India, Ghats, Central India, Assam, Dehradun, Chittagong, Choota Nagpur, Shivalik ranges, Punjab, Kulu, Kumaon, Sikkim, Bahralach, South India, Mysore, Nagpur and East Khandesh.
12.	SANTALACEAE	East Indian Sandalwood.	Mysore, Malabar, Coimbatore, Coorg, Hyderabad, Karnatik, Nilgiris, Kannery, Southern Madras, Indore, Bhopal. Kolhapur, Madura, Assam.
13.	UMBELLIFERAE	Ajowan, Anise, Asafoetida, Caraway, Coriander, Cumin, Dill, Fennel, Sumbul.	Bengal, Assam, Ujjain, Dhar, Punjab, Nepal, Kashmir, Central India, Kangra, Bombay, Madras, Tippera, Mysore & Gujerat.
14.	IRIDEAE	Orris and Saffron.	Northern India, especially Kashmir.
15.	LEGUMINOSAE	Cassia, Copaiba & Mimosa.	Ratnagiri, Punjab, Uttar Pradesh, Bihar, South India, and Malabar.
16.	LILIACEAE	Hyacinth, Garlic & Onion.	Punjab, Uttar Pradesh, Madhya Pradesh garlic and onion throughout India.
17.	LYTHRACEAE	Hina	Throughout India.
18.	MALVACEAE	Ambrette seeds	Uttar Pradesh.
19.	NYMPHEACEAE	Lotus.	Common in Kashmir.
20.	OLEACEAE	Various kinds, of Jasmines.	Scattered all over India.
21.	PIPERACEAE	Black pepper, Betel leaves, Cubeb.	Uttar Pradesh, Madhya Pradesh and South India.
22.	ROSACEAE	Bitter almonds and Rose.	Peshawar, Kashmir, Kullu, Kangra, Amritsar, Aligarh, Ghazipur, Jaunpur and more or less throughout India.
23.	SAPOTACEAE	Bakul.	Bengal, Orissa and South India.
24.	SOLANACEAE	Red pepper.	Throughout India.
25.	VERBENACEAE	Verbena and Chaste.	Madhya Pradesh, Madras and Bengal.
26.	VIOLACEAE	Violet.	Temperate Himalayas, Khasia Hill and Nilgiris.
27.	THYMELIECEAE	Agar.	Assam.
28.	ZINGIBERACEAE	Galangal, Bengal Cardamom, <i>Curcuma zedoaria</i> , Cardamom, Ginger.	Konkan, Bengal, Assam, Darjeeling, Chittagong, Kashmir, Sikkim, Ambala, Dehradun, Almora, Bhandara Bilaspur, Mysore, Travancore, Cochin, Coorg, Northern Kanara, Wynaad, Madras, Malabar and Bangalore.

Active Parts of Aromatic Plants

As stated above the essential oils may be seated in particular parts of the plant or in whole of the plant itself. A brief discussion as to the active parts of aromatic plants yielding the essential oils may be of interest.

GUMS.—No systematic study appears to have been made of aromatic gums. In the forests of India aromatic exudations are collected and sold in their natural forms. If these gums are properly investigated they may be found to be sources of valuable perfumery ingredients. The oleo-resins derived from the natural gums are valuable fixatives commonly employed by the perfumery industry. For instance the Tolu and Peru Balsams of South America, the benzoin of Thailand, the oibanum (Frankincense) from Africa and the Galbanum and Myrrh of ancient fame are all well known generally.

HERBACEOUS PLANTS.—Amongst the vegetable kingdom, the genera of *Artemisia*, *Ocimum*, *Pogostemon*, *Mentha*, *Chenopodium*, etc. are valuable sources of aromatic oils. In India, except in a few cases, no serious study has been made of plants which develop essential oils. The investigation so far carried out is mainly in connection with Labiatae and Compositae families with particular reference to *ocimum*, peppermint, *lavendula*, *calendula*, *artemisia*, etc.

A small quantity of worm-wood oil from *Artemisia absinthium* was distilled in South India. Another species of *Artemisia* known locally as 'Davana' is cultivated on commercial scale in Mysore and essential oil of good quality is distilled. Similarly different species of *Ocimum* growing in Uttar Pradesh yield a good essential oil. Experimental cultivation of Lavender and Mint in Jammu and Kashmir state have shown promising results.

ROOTS.—A large number of roots and rhizomes such as turmeric, ginger, etc., are grown in India. The Indian Institute of Science Bangalore, many years ago, carried out an investigation on the essential oils from the roots of *Curcuma aromatica* (Kasturi-manjal) and *Curcuma zedoaria* (Kachroora) which grow wild in Malabar in South India. The powders from these roots have been used for toilet and medicinal purposes in South India for a long time. The oil from ginger is of the same quality as that obtained from ginger roots from other parts of the world, particularly from Jamaica and Africa. The main constituent of ginger oil is zingiberene and the oil is valued in the perfumery and pharmaceutical industry, as well as for flavouring beverages.

SEEDS.—A number of essential oil bearing seeds (including those from dried fruits) are grown in India. For example, the seeds of cumin, dill, fennel, fenugreek, grow abundantly in India and are exported for the distillation of essential oils which are valued in pharmacy. Same is the case with coriander and cardamom seeds. In the case of the coriander, the oil can be distilled both from the leaves and the seeds and the oil from the seeds has also been found valuable to the perfumery industry. The main constituent of the oil was found to be linalyl acetate. The oil from the cardamom seeds has also been studied and is useful both in the perfumery and pharmaceutical industries.

The water distillation method is suitable for producing oil from roots, grasses, leaves, wood and some varieties of flowers ; it is, therefore, the most popular and universal method employed for the extraction of essential oils. In the opinion of some manufacturers a scientifically planned water distillation process has certain advantages over the steam distillation process also.

In particular instances it has been observed that this does not produce the desired results and the long action of steam and boiling water causes hydrolysis and decomposition of certain compounds of the oil. A few types of flowers (this is the case with some very delicate ones), yield no oil at all on distillation. The oil is either destroyed by the action of steam or the minute quantity of oil distilling over is lost in the large volume of distillate. This applies to jasmine, tuberose, violet, narcissus, mimosa, etc. Flowers of this type, therefore should be processed by methods other than distillation. This fact was recognised empirically ages ago and these processes yielded fragrant pomades. From this primitive beginning, there developed in the Grasse region of Southern France, in the course of many years, a highly specialised industry, employing the processes of maceration and of enfleurage and for the last forty years, the modern process of cold extraction with volatile solvents. Despite similar but much less important developments in other parts of the World (Bulgaria, Egypt, Algeria, Sicily, Calabria, Madagascar, etc.) Grasse remained the centre of this picturesque industry, which today supplies the perfume manufacturers with a great variety of highly priced so-called natural flower oils. Representing the authentic scent as exhaled by the flowers, these flower oils are the finest and most delicate ingredients at the disposal of the modern perfumer, enabling him to create masterpieces of his art by skilful application and blending.

The term 'Natural flower oil' as used today commercially, does not include the distilled essential oils ; it applies only to flower oils obtained by the methods of enfleurage, maceration and extraction with volatile solvents. A few oils, e.g., those derived from rose petals and from the blossoms of sour (bitter orange tree) can be isolated either by distillation or by extraction. The oils are then called essential oils and natural flower oils respectively the latter reproducing and representing the original scent of the flowers in a more complete way. It is principally the elaborate apparatus required and the higher cost of manufacturing which prevent a more general adaptation of this process of extraction.

EXPRESSION.—This method has been developed particularly in Italy, for the expression of delicate essential oils from the peels of citrus plants such as orange, lemons, etc. The peels are pressed over sponges from which the absorbed oil is recovered by squeezing with hand. It is no doubt possible to extract the essential oil from citrus peels by steam distillation, but the oil has been found to lack the freshness of aroma which is usually associated with hand pressed oils which fetch a better price. This method is generally practiced in India for production of oils of lemon and sweet oranges.

ENFLEURAGE.—This method is employed for extracting the oil from flowers like jasmine, tuberose, cassia, etc. by allowing the flower to come in close

contact with pure fat on specially devised trays. The fat absorbs the odoriferous bodies present in the flowers and when it is saturated with the perfume of the flowers, it is shaken with alcohol at low temperature which dissolves the perfume but practically no fat. This method of extraction was known and practised in India many centuries ago and has been mentioned in *Ain-i-Akbari*. It is practised in India even today for the production of scented oils which are generally made from sesamum seeds. Wetted sesamum seeds are placed in alternate layers with the flowers and are left over for 12 to 18 hours; the seeds are then crushed in a mill and the scented oil is obtained. The Indian method of enfleurage is, however, different from the European method where the extract is obtained in solution in natural waxes present in the flowers. From the 'concrete' the natural flower oil, often called the 'absolutes' is separated by suitable solvents. These 'concretes' and the 'absolutes' obtained in the enfleurage method are very expensive but are invaluable in the blending of high quantity perfumes as well as synthetic flower oils. This method is adopted by the leading Indian perfumery industries.

SOLVENT EXTRACTION.—This process is generally used in recovering oils having a delicate flowery note, which may ordinarily be destroyed under steam distillation. The solvent commonly employed is petroleum ether of low boiling point. The solvent is boiled in a separate vessel, and its vapours are allowed to enter a rotary drum in which baskets, containing the flowers to be extracted, are fitted; these baskets are pierced so that the vapours pass freely through the flowers as well as from one basket to another; by keeping the drum in rotation, fresh solvent comes at regular intervals in contact with flowers. There is also another method in which the solvent is allowed to pass through a series of vessels and extraction is carried out by the counter current system in which fresh solvent is allowed to pass through a series of vessels and extraction is carried out by the counter current system in which fresh solvent is allowed to pass over the flowers which have already given up most of their perfume by previous extraction. The saturated solvent is evaporated and an 'absolute' of the flower perfume is obtained. Although this method has greatly improved lately and has partly replaced the enfleurage method, on account of its rapidity of execution, the quantity of 'absolute' obtained by the enfleurage method is still considered to be far superior. In fact both the methods are coupled in modern factories in the West and the flowers used in the enfleurage method are subsequently treated with volatile solvents to dissolve the fat. The extracts of kewda, bela, chameli, keshar and agarwood manufactured by this process have been marketed with success by the Hindustan Aromatic Co. in India.

The production of essential oils in India is still practised by the 'attar' distillation method as mentioned above, though in rare cases the method of steam distillation is also employed as in the case of Government Sandalwood oil Factory at Mysore. The manufacture of pure natural oils of flowers or 'absolutes' of jasmine, moghra, bokul, etc. is limited to one or two firms in India but the 'attars' of these and other flowers are produced at Kanauj and Ghazipur, where the

with or entirely replaced by nitrobenzol, etc. Earlier methods of adulteration were crude and the advancement of chemical science made them easy to detect and they were for the most part abandoned. But chemical science, while making the detection of the old methods easy, provided a basis for scientific adulteration which aims at duplicating the physical and chemical characteristics of the pure oil as accurately as possible. Needless to say, such adulterations are not easy to detect. In case where oils are judged by the actual numbers or esters numbers, i.e. by tests showing the percentage content of alcohols or esters, the oil is stretched with an inert material or with poorer oils and then the requisite amount of some alcohol or ester is added to bring the analysis upto the proper figures. To take a specific example, French oil of lavender is stretched with oil aspic which contains practically no esters; then a certain amount of odourless ethyl phthalate is added to produce the correct ester number on analysis. Sometimes a better product is made by the addition of synthetic linalyl acetate which no chemical analysis can differentiate from the linalyl acetate of pure oil of lavender. In a similar way, the washed terpenes of oil of lemon, worthless from the perfume standpoint, may be treated with the proper amount of citral, producing a fake oil of lemon. Oil of bitter almonds may often be adulterated with benzaldehyde, its principal constituent which can be made far more cheaply by chemical means. Even benzaldehyde may be sometimes adulterated with much cheaper oil of mirbane or nitrobenzol, a fraud which can be easily exposed by the fact that benzaldehyde is perfectly soluble in a solution of sodium bisulphite.

The detection of these clever chemical adulterations requires a careful study of each case, with the application of the most suitable tests, and is frequently almost impossible except by the most delicate test, that of odour value. Usually, however, even the cleverest adulteration will affect some one of the physical constants and even when it is not practical to identify the adulteration sufficient evidence can be obtained to indicate that fraud has been committed.

Present Position of Essential Oil Production in India

The production of essential oils in India is carried out, from North to South, with important centres of production in the Punjab, Uttar Pradesh, Madhya Pradesh, Orissa, the Nilgiris, Mysore and Travancore. The important oils, apart from the Indian 'Attars' are: (a) Eucalyptus oil (b) Ginger grass oil (c) Khus oil (d) Lemon grass oil (e) Linaloe oil (f) Palmarosa oil (g) Rose oil (h) Sandalwood oil (i) Turpentine oil. Small quantities of other oils are also produced in India but there is no proper organised effort and the production is thus spasmodic. A good beginning was made to produce citrus oil on a commercial scale in the Punjab (Pakistan) and in the Bombay state, and of ajowan oil at Indore. Similarly at Kuppam in South India, efforts were made to distill patchouli oil from imported Singapore leaves whilst spasmodic production of geranium oil is reported from Yercaud in Shevaroy Hills and of wormwood and camphor oil in the Nilgiris. In Mangalore and in Orissa, cinnamon oil is being produced by crude methods. It will be appropriate here to refer briefly to this development of the essential oil industry in India as reported by Narielwala. Mention will also

be made of the few 'attars' which are commonly distilled and greatly valued in India.

Ajowan Oil (*Carum copticum* Benth.).—This oil is obtained from the Ajowan seeds and has been used in the pharmaceutical and perfumery industry and is produced at present on a commercial scale at Rao in Indore State ; a little of it is also produced in the Utter Pradesh. In Indore the oil is produced by steam distillation, one ton of seeds yield about 56 lb. of oil. From the oil are also recovered thymol crystals, after the extraction of which the residue is sold under the new trade name of 'Thyme oil'. The price of Ajowan oil is Rs. 1/8/- per lb. whilst that of Thymol is Rs. 6/4/- per lb. and of 'Thyme oil' Rs. -/12/- per lb. All the products from the Indore Factory are of excellent quality and with the support of the Indian pharmaceutical and other industries this new industry has been successful.

Camphor Oil (*Cinnamomum camphora*).—This oil is produced only at the Hallacary estate in Coonoor, where 200 acres were planted with camphor trees (*Laurus camphora*) 30 years ago. On distillation of the leaves, solid camphor and camphor oil are obtained. In this estate about 500 lb. of camphor and 150 lb. of camphor oil are being produced per annum and these find a ready market. The world production of camphor oil is about 4,500 tons per annum according to Schimmel & Co. and it is almost entirely produced on a large scale in Japan. Camphor trees yield camphor oil after these are more than 15 years old but on account of the commercial importance of its products, it would be worthwhile to grow these trees on a larger scale in various parts of India. According to Simonsen the amount of camphor and the oil obtained from different parts of the tree by steam distillation is as follows:

Green leaves	....	40.6 per cent.	Branches	0 to 12 per cent.
Leaves	....	43.0 per cent.	Roots	24.0 to 28.7 per cent.
Dry leaves	....	30.5 per cent.	Stumps	17.5 to 25 per cent.
Twigs		20 to 35.5 per cent.		

Simonsen and others have shown that camphor trees can be successfully cultivated in all parts of India with an annual rainfall of 40 inches and over and a satisfactory yield of oil rich in camphor, can be obtained from the leaves. The imports into India in 1928-39 of camphor was 1,868,694 lb. valued at Rs. 21.88 lakhs and of camphor oil about 4,600 gallons valued at Rs. 11,000. By cultivation of camphor trees it would be possible to meet the country's demand.

Cinnamon Oil (*Cinnamomum zeylanicum*).—This oil is distilled by a few firms in Bangalore by crude methods from the bark as well as the leaves of the cinnamon trees which grow abundantly in Malabar and South Kanara. The oils from the leaves and the bark differ in their chemical constituents, the oil from the bark being more valuable, though both the oils are of considerable importance in pharmaceutical industry, in flavouring of foods and manufacture of aromatic chemicals. The oil from the bark is sometimes erroneously known as cassia oil. The confusion seemed to arise because cassia oil is obtained from the bark of *Cinnamom cassia* and has a cinamon-like odour and from it (cassia oil) the import-

ant aromatic chemical cinnamic aldehyde can be obtained. The major constituent of cinamon bark oil is also cinnamic aldehyde. The oil is prized for its refined odour in expensive perfumes. The leaf oil is a source of eugenol which is also present in clove oil. In view of the fact that cinnamon trees thrive in India, the development of the cinnamom oil industry from the bark as well as the leaf is an immediate possibility. The total production of cinnamon is 360,000 lb. mostly from Ceylon.

Citrus Oil.—A promising start on a small scale in the production of citrus oils was made at Utran in East Khandesh in Bombay State and at Ronala Khurd in Montgomery District, Punjab (Pakistan). The lime tree is indigenous to India and grows throughout the country. In Bombay State the area under cultivation is estimated to be 1,200 acres. The oil is steam distilled from the rinds and from juice of the fruits; it is reported that on an average about 2 per cent of oil is recovered. The lime oil is used as a flavouring material for food and beverages and there is demand for it both in Europe and America. Its pre-war price in London market varied from 21s. to 44s. per lb. The development of citrus oils industry on a large scale is possible in India. According to Parry, the Italians took seeds, seedlings and grafts of citrus trees from India for starting plantations and as a result of organised cultivation the annual production of citrus oil in Sicily in 1935 according to Schimmel & Co. was as follows:

			Sicilian lb.
Bergamot oil	....	....	7,50,000
Lemon oil	....	....	25,00,000
Orange oil	....	....	6,00,000
Total	....		38,50,000

The value of these oils is about Rs. 4 crores and the Italian Government are paying considerable attention to the cultivation and development of this industry on a large scale.

In India oranges, sweet limes, lemons and grape fruits grow well and in abundance in many places. The Madhya Pradesh, the Punjab, the Khasi Hills in Assam, the Shevaroyes and the Wynaads on the Western Ghats, Orissa and Coorg are important centres of cultivation of citrus trees. The following varieties of citrus plants are reported as being grown in India, the varieties of essential oils that can be obtained from the peels, the flowers or the leaves are indicated, against each.

NAME OF TREES	ESSENTIAL OIL AVAILABLE
1. <i>Citrus bigaradia</i> Risso (Bitter Orange)	Petitgrain oil from the leaves. Bitter orange oil from fruits.
2. <i>Citrus aurantium</i> Linn. (Sweet Orange—'Narangi')	Oil of Neroli (Portugal) from flowers ; Oil of sweet orange from fruits and rind.
3. <i>Citrus decumana</i> Linn. (Paradise Apple—'Batabi 'Limbu')	Grape fruit oil from peel.

NAME OF TREES	ESSENTIAL OIL AVAILABLE
4. <i>Citrus nobilis</i> Lour. (Mandarin or Maltese Orange)	Oil of Mandarin from leaves, oil of Mandarin from fruits.
5. <i>Citrus medica</i> Linn. (The Citron)	Oil of Limette from leaves of citron from fruits.
6. <i>Citrus limonum</i> Wall. (Lemon—'Kaghzi')	Oil of Lemon from fruits.
7. <i>Citrus limetta</i> (Sweet Lime—'Mitha Limbu')	Oil of Limette from flowers. Oil of Limette from fruits.
8. <i>Citrus acida</i> Roxb. (Sour Lime—'Limbu')	Oil of lime from fruits.

Italy was until lately the main source of supply of citrus oils, but California and very recently Palestine have succeeded in developing this industry. The citrus oils are indispensable in the manufacture of fine perfumery, but their largest use is as flavouring agent in foods, confectionery, aerated waters and tobacco. At present in all the citrus plantations in India a considerable quantity of fruit is allowed to rot and go waste in the production of marmalade, fruit jams and syrups. Any attempt to recover the oil from the peel of the wasted fruit would be profitable. India imports annually over a hundred tons of citric acid of the value of about Rs. 1.25 lakhs; it also imports sodium and potassium citrates, and about 18,000 lb. of lemon oil valued at Rs. 94,000. The total imports amount to Rs. 2.5 lakhs per annum. A certain amount of extraction of oil from the peels of the sweet orange (Santara) has been done at the Kerala Soap Institute, Calicut, and it could be easily carried out in Coorg. According to the Kerala Soap Institute, the cost of distilling the orange oil will not exceed Rs. 2 per lb. which compares very favourably with the pre-war price of imported oil of Rs. 5 per lb.

Eucalyptus Oil (*Eucalyptus globulus* Lab.).—This is obtained from the leaves of the eucalyptus trees which thrive in the Nilgiris, the Anaimalai and the Palni Hills. The area under cultivation in the Nilgiris is about 2,550 acres whilst the production of oil is nearly 22,000 gallons per annum, equivalent to about 85 tons valued at Rs. 3.0 lakhs at Rs. 1/8/- per lb. The entire production is consumed within the country and in addition India imports about 2,000 gallons of eucalyptus oil of the value of Rs. 25,000 from Australia. The eucalyptus trees in the Nilgiris are however, steadily disappearing as they are being rapidly used as firewood. It is understood that Uttar Pradesh, Bihar, as also certain tracts in Orissa are suitable for eucalyptus plantation and as eucalyptus oil has commercial importance, it would be of benefit to the country if its cultivation on a large scale is undertaken in these areas. Cultivation of another variety of eucalyptus tree known as *Eucalyptus citriodora* may also be taken up. The leaves of this variety are reported to be rich in citronel which is an important aldehyde in perfumery as well as in pharmaceutical industry; it is also a starting medium for the manufacture of menthol. The manufacture of eucalyptus oil is carried out by primitive methods at present as a result of which the purity of the oil varies

from batch to batch. It is stated that Indian eucalyptus oil is deficient in its cineole content and therefore does not come up to the latest B.P. specification. The Indian oil contains low percentage of cineole and is considered better than the Australian oil which contains valeric, butyric and caproic aldehydes, and which cause irritation of the throat resulting in cough. The oil distilled in the Nilgiris, even by the primitive methods, is better than the Australian oil obtained from the same species.

Geranium Oil (*Pclargonium graveolens* and *P. odoratissimum*).—This oil is distilled on a small scale, about 600 lb. per annum, at Yercaud on the Shevaroy Hills, from a variety of French geranium, probably *P. odoratissimum*. The oil has been reported to be of a very good quality. The first plantation of *Geranium rosa* was established in Yercaud on the Shevaroy Hills near Salem in South India by a Frenchman in his estate. He was one of the pioneers in the manufacture of essential oils, for in addition to planting *Geranium rosa*, he had planted orange, patchouli and jasmine with a view to set up an essential oil industry in India. He, however, sold his plantation after about 10 years and further development of the industry stopped. Distillation of geranium oil on a small scale under controlled conditions is still being carried out at this estate and it is reported that an acre of land under *Geranium rosa* cultivation yields about 8 lb. of the oil. The present price of oil is Rs. 25/- per lb. Geranium oil is of great importance in the perfumery industry as, along with khus and patchouli oils, it may form the basis of many good perfumes. It is also the basic medium for the manufacture of rhodinol and its esters. The world production of geranium oil is estimated at about 150 tons, the bulk of which comes from the Reunion Islands and Algeria. The Nilgiris and the Shevaroy Hills are well suited for the cultivation of geranium; and India can produce geranium oil of first quality which will have not only a market in India but also a large market abroad. The right species of the plant should, however, be studied for cultivation.

Linaloe Oil (Mexican variety, *Bursera delpechiana*, *Bursera aloexylon*).—This oil is produced at Tanguni Estates about 11 miles from Bangalore from the carpels, though the oil can some times be distilled from the leaves as well as the wood. The distillation of the oil is carried out with modern stills under scientific control. About 20 years ago, nearly 220 acres of land were planted at Tanguni Estate with Linaloe trees and as these trees take a number of years to grow the distillation of oil was only started few years back. The oil produced at the estate is of an excellent quality and can be satisfactorily used in the blending of many perfumes for soap industry. The present production is reported at about 1,200 lb. per annum, but as the trees grow older it will be possible to distill a larger quantity.

Rose Oil (*Rosa damascena* Linn.).—This is a very important oil for the perfumery industry, but it is practically totally ignored and neglected in India at present. The rose oil of India or as it is more popularly known the Otto of Rose, was known all over the world in olden days and has the reputation of being the finest quality. Not only has India lost its position to the Balkan countries, which

are today the biggest producers of the Otto of Rose of some of the finest qualities, but the production of Rose oil for internal consumption also has been neglected totally; today not more than 5 to 7 lb. of it is produced in India as against 6 to 7 thousand pounds produced in the Balkan countries particularly Bulgaria. Even to-day the small quantity of Rose Oil that is produced in India is almost as good as the Bulgarian Rose oil and it is of vital importance to the country that the manufacture of Rose oil should be undertaken on a much larger scale than hitherto. Ghazipur, which was once known all the world over as the centre of Indian Rose oil, now produces roses on a very small scale but on account of the degradation of the species and the impoverishment of the soil, the centre of gravity for the production of Rose oil has shifted to Barwana in Aligarh District of U. P. The season for roses in Barwana lasts for only six weeks from the middle of March till the end of April, and it is reported that during this period as much as 200 maunds of rose petals are distilled per day and at the height of the season, which lasts for only about a week, the receipt of flowers comes to as much as 1,000 maunds per day. Most of the rose petals are, however, used up for the manufacture of Rose 'attar' and only about 5 to 7 lb. of pure Otto of Rose is produced per annum. The distillation at Barwana is carried out by distillers from Kanauj by old methods and it is reported that about 13,000 lb. of rose petals give about 1 lb. of Rose oil (which means a yield of about 0.008%), this is in addition to Rose water which is obtained in the process. If a more modern method of distillation is adopted, it should be possible to obtain a higher yield. Even with the present methods, if all the rose petals in Barwana were to be used for the distillation of Otto of Rose and not of 'attar', the production of Rose oil could be increased to at least 50 lb. per annum. Systematic study of the manufacture of Otto of Rose by modern methods has been carried out by the Industries Department of the Uttar Pradesh and it is stated that the yield of oil can be raised to as much as 0.015 per cent. by using an improved type of still, i.e. we can obtain from the existing crop of flowers at Barwana twice as much oil as yielded by the crude method of distillation. If the Government of the Uttar Pradesh were to set up a demonstration still of a modern design at Barwana and show by practical demonstration to the distillers the advantages of improved methods of distillation, permanent result of great benefit to the industry can be obtained. A wider cultivation of roses and a production of Otto of Rose on a large scale is considered to be of immediate and considerable importance to India.

It is understood that in South India as much as 125 acres are under Rose cultivation, but no attempt was made there for distilling rose oil on a commercial scale. So far as our information goes *Rosa damascena* is the only suitable variety for the distillation of the oil, but a systematic study of the different varieties of Rose grown in India may reveal that some of the other varieties may be equally suitable for distillation. The development and extension of rose cultivation in India on a wide scale is of great importance as the price of Rose oil from the Balkans range from Rs. 600 to Rs. 1,000 per lb. and India could easily share in its production.

Turpentine Oil (*Pinus longifolia* Fam. Coniferae).—The oil of turpentine is obtained by steam distillation of resin which exudes from the pine tree (*P. longifolia*) which are tapped at regular intervals by incision. The three factories, one at Bareilly in Uttar Pradesh, another in Jammu (Kashmir) and a third in Himachal Pradesh are carrying out the manufacture of turpentine oil. Turpentine itself is not used in the perfumery, but it forms a starting material for a number of substances which are used as perfume, i.e. terpineol (synthetic lilac) and camphor. This mostly depends on the pinene content of the oil. Turpentine oil produced in India unfortunately contains only 20 per cent. of α -pinene. There are several varieties of pine trees growing in India, i.e. *Pinus excelsa*, *P. khasya*, *P. merkussii* which yield oleoresin containing upto 90 per cent of α -pinene. If these are exploited at reasonable cost, new industries for the production of camphor and terpineol can be started.

Sandalwood Oil (*Santalum album*).—Sandalwood oil is obtained from the wood of the Sandal trees which grow largely in the forests of Mysore, Coorg and Bombay Presidency. The wood is commercially valued according to size, weight, physical appearance, etc. and has varied domestic uses. The wood is rich in oil and according to work carried out at the Forest Research Institute Dehra Dun, the oil is found in both billets and roots. The wood is generally disintegrated into small fine powder before it is taken to the still for the extraction of the oil. The manufacture of Sandalwood oil is conducted chiefly in Mysore and on a moderate scale at Kuppam, Mettur, Bombay, Kanauj and Karkal (S.K.). Most of the sandalwood oil factories operate modern stills with steam and the quality of the Indian oil is approved all over the world. There are, however, some factories in Mangalore which still extract the oil by crude methods of distillation, but their production is negligible and of little importance. According to Sastry, the Government Sandalwood Oil Factory Mysore, was only set up during the last World War when the export of sandalwood to Europe was stopped and the Government of Mysore took the logical course of manufacturing sandalwood oil in Mysore for export, rather than exporting the wood itself. The last World War thus gave an impetus to the sandalwood oil industry in India with the result that today India is not only self-sufficient for its requirements of sandalwood oil but has developed a valuable export market for its oil. With the export of the oil, the export of sandalwood has considerably diminished, though there is still a considerable export of Mysore wood to America where the oil is distilled for the American market, on account of the prohibitive duty imposed by the U. S. A. Government on the import of sandalwood oil. The production of Sandalwood oil in India is estimated at 100 tons per annum, the value of which at 1946 year's price of about Rs. 10/- per kg. comes to 22.5 lakhs. With the development of the soap, toilet and perfumery industries and large scale manufacture of pharmaceutical goods in India, there is every reason to believe that the manufacture of sandalwood oil will progress still further in the years to come. The British Pharmacopoeia has introduced a new specification providing for a minimum of percentage of santalyl acetate. This addition may serve as a handicap to the sale of Indian sandalwood oil if this specification is

insisted upon. The attention of the sandalwood oil manufacturers should be drawn to this new factor.

Salresin or Chue Oil (*Shorca robusta*).—The oil is extracted by crude methods in Cuttack from Sal resin which is an exudation from Sal trees which grow in Orissa. No systematic investigation appears to have been carried out with regard to this oil and it is not possible to state whether and to what extent it can prove useful in the perfumery industry. Investigations were carried out in Orissa to improve methods of manufacture of this oil, but on trial it was found that the oil produced in improved stills was thinner than the oil produced by the crude method and as such did not command any market. A systematic investigation of this oil would be desirable as it is reported that some years ago, as much as 1,000 lb. of this oil was extracted every day and was consumed by Kanauj distillers in the manufacture of incenses and attars. The sample of the oil examined were, however, not satisfactory.

Aromatic Grasses.—There are number of essential oil-yielding grasses found in India and all these belong to the tribe *Andropogonaceae* which is particularly rich in aromatic species. According to Stapf, the aromatic character of these grasses is so pronounced that it attracted the attention of man at a very early period of his history. These found a place in the performance of religious rites, in domestic medicines in the dispensaries of indigenous practitioners and in the compounding of spices and perfumes. Then to twelve species of *Cymbopogon* occur in India. Most of these have aromatic properties and some yield essential oils of commercial importance. Their identification and classification is difficult not only because they hybridise freely and produce numerous transitional forms, but also because they often do not flower at all. Commercially important essential oils derived from these grasses are: Indian lemon grass oil obtained from *C. flexuosus*; West Indian lemon grass oil obtained from *C. citratus*; palmarosa oil obtained from the Motia variety of *C. martini*; and citronella oil obtained mostly from the Lena Batu variety of *C. nardus*. The oil obtained from *C. coloratus* is included among the lemon grass type of oils although it differs in composition and resembles a mixture of citronella and lemon grass oils. Ginger grass oil derived from the Sodra variety of *C. martini* is inferior to palmrosa oil and is of minor commercial importance. An oil similar to ginger grass oil is obtained from Naal grass, probably *C. nervatus* Choiv., found in Sudan. The rhizomes and roots of *C. jwarancusa* and also of *C. schoenanthus* Spreng. are credited with medicinal properties. The latter is a typical desert species and is a common camel fodder. *C. gidarba* Haines (syn. *Andropogon gidarba* Buch.-Ham ex Wall.) distributed in western Himalayas and Bihar, and recently reported also from Madras State, is a good fodder grass. *C. polyneuros* Stapf. (syn. *Andropogon schoenanthus* Linn. var. *versicolor* Hack.), found in the south western parts of India and in Ceylon, is used as a fodder grass for horses. Delft grass oil, obtained by subjecting the grass to steam distillation is prepared to a limited extent in Ceylon.

THE FOLLOWING IS A LIST OF ABOUT 20 WELL DEFINED AROMATIC GRASSES :

1. *Cymbopogon caesius* Stapf. (Ginger grass).
2. *C. citratus* Stapf. (Lemon grass).
3. *C. clandestinus*.
4. *C. coloratus* Stapf.
5. *C. confertiflorus* Stapf.
6. *C. flexuosus* Stapf.
7. *C. jwarancusa* Schult. (Stapf.).
8. *C. javanensis* Hofmann.
9. *C. martini* (varieties Motia and Sofia) (Rosha grass).
10. *C. nardus* Rendle (Citronella grass).
11. *C. nervatus* Chiov.
12. *C. odoratus* Liso.
13. *C. pendulus* Stapf.
14. *C. polyneuros* Stapf.
15. *C. schoenanthus* Spreng.
16. *C. senaarensis* Chiov.
17. *C. winterianus* Jower.
18. *Andropogon kuntzeanus* Hack. (var. *foveolata*, closely resembling *Cymbopogon odoratus*).
19. A new specie of *Andropogon* which Stapf. reported as coming nearest to *C. jwarancusa* Schult.
20. *Vetiveria zizanioides* Stapf. (Khus grass).

Of the above named grasses the following grow in abundance in many parts of India. Citronella grass does not grow in India, but it has been included because its oil is imported into India and the grass can be propagated without much difficulty.

1. *Cymbopogon citratus* (Lemon grass).
2. *C. martini* (Rosha grass).
3. *C. caesius* Stapf. (Ginger grass) and
4. *C. nardus* (Citronella grass).
5. *Vetiveria zizanioides* (Khus grass).

A more systematic exploitation of these grasses and their distillation by more scientific methods will yield considerably larger quantities of oils. Simonsen investigated the oil from the grass *Cymbopogon jwarancusa* and found that it contained about 80 per cent. of piperitone which is capable of yielding both menthol and thymol. As this grass can grow on the plains as well as the hills, a further study into its propagation would be worth investigation in view of the possibility of manufacture of menthol and thymol from its oil. The Khus grass in the Punjab and in South India has remained untapped and its exploitation will enrich the country and give employment to a number of people. The Khus oil produced in U.P. and Bharatpur hardly meets the need of the country and

India imports Vetiver oil from Java to make up its total requirement. This import from Java appears quite unnecessary when large quantities of Khus grass are allowed to go waste in the Punjab and South India. Similarly India imports annually about Rs. 2.5 lakhs worth of citronella oil from Java and Ceylon.

Citronella Grass (*Cymbopogon nardus*).—This grass, the source of citronella oil of commerce occurs in two cultivated forms. 'Lena Batu' and 'Maha Pengiri' or old citronella grass. Both forms are cultivated in Ceylon, but at present 'Lina Batu' is the most extensively cultivated being more hardy; 'Maha Pengiri' is the principal cultivated grass of Java. The cultivated forms of this grass are not known anywhere in India at present. *C. nardus* var. *confertiflorus* occurs in the Nilgiris, Anaimalai and Rampa Hills of Madras, and in the remote north eastern corners of Assam. It is also indigenous in Mysore and East Punjab. It yields an oil which is similar but inferior in quality to Citronella oil, and is therefore not exploited for the production of the oil. The oil is extensively used as soap perfume and in insecticidal fluids. India does not produce any quantity of this oil and the requirements are met by imports mostly from Ceylon. India imported 62,750 lb. of this oil in 1938 and 69,404 lb. in 1937 and since then the consumption and imports have increased considerably. It would, therefore, be to the immediate advantage of India to undertake the cultivation of Citronella grass on a large scale so that it may not be necessary for the country to import its requirement of Citronella oil from Java and Ceylon. Citronella oil is rich in geraniol and citronellal and propagation of this variety of grass will yield to the country a fine material for making important aromatic chemicals such as geraniol, citronellal, and their derivatives which are also imported into India for use in the manufacture of perfumes. Another variety of the grass is reported to grow in Cochin, Travancore, Mysore and in East Punjab and the true variety of Citronella grass has been raised successfully on an experimental scale in Gazipur. It should not, therefore, be difficult to propagate this grass in India.

Ginger Grass Oil (*Cymbopogon caesius* Stapf.).—Ginger grass grows wild in some of the southern districts of Travancore where it is known as Inchippul. There are two varieties of this grass, one white and the other red, but the oil from both the varieties is similar in respect of odour as well as other qualities. The oil is distilled by crude methods from leaves, grass and flowers on a very small scale and hardly 4,000 lb. of it are produced in a year. Ginger grass oil is a sweet smelling oil but is different in constituents from lemon grass and palmarosa oil, although it resembles palmarosa oil in odour. Ginger grass oil is useful for cheaper varieties of soap blends and it would, therefore, be worthwhile to develop the distillation of ginger grass oil on a larger scale.

Khus Oil (*Vetiveria zizanioides*).—This oil is distilled from the roots of the khus grass which grows in abundance in different parts of India, viz. Malabar, Orissa, the Punjab, Madhya Pradesh and Bharatpur State. The grass grows wild and no systematic effort has been made to cultivate it or to find out its varieties, or which of them will yield the best quality or the highest percentage of the oil. The distillation of the roots is carried out by primitive methods

on a fairly large scale in Bharatpur and in Uttar Pradesh and to a small extent also in the Punjab and in Orissa, but no attempt has been made to extract the oil so far in Malabar. A number of varieties of khus grow wild in many parts of India. A systematic study of these should be carried out and only the best varieties should be taken up for propagation. Khus oil is an important ingredient in the perfumery industry and India produces nearly three lacs of Rupees worth of this oil annually; even then India imports considerable quantities of vetiver oil which closely resembles khus oil in its chemical constituents. Attempts to increase the production of khus oil, therefore, should be made. Large quantities of root can be grown with a yield of 0.4 per cent. of oil. The price of the oil varies from Rs. 40/- to Rs. 80/- per lb.

Lemon Grass Oil (*Cymbopogon citratus* Stapf).—This grass grows mainly in the northern districts of Travancore and in a small area in Cochin at altitudes of about 500 ft. Formerly the grass was found in central and southern districts of Travancore but this is no longer the case now. The cultivation of the grass is very haphazard and scattered over large areas, some of which are highly inaccessible. Lemon grass is a hardy plant and grows in almost any kind of soil, though it is reported that the more fertile the soil, the more the citral content in the oil. The life of the grass varies from 6 to 15 years, but 8 to 10 years is the normal productive life. The sowing of the grass takes place toward the end of March or beginning of April and it is reported that the best yield of oil is obtained during the dry weather. Normally there are four cuttings in the year at an interval of 6 to 8 weeks starting in May and ending with December. Consumption of the oil in the country is small and the bulk of it is exported to Europe and America from Cochin. The export of the oil is on the increase and whilst 216 tons of oil were exported in 1925, the export went up to 390 tons in 1938. If improved methods of distillation are employed and the quality of oil is maintained, there is no reason why lemon grass industry should not expand and prosper. The Travancore Cochin Government is taking adequate steps in this direction and at present Travancore is one of the chief producers of pure lemon grass oil in the World. It is an important source of citral used in the production of a number of chemicals of industrial importance producing ionones required for the synthesis of Vitamin A. The manufacture of Vitamin A is not being carried out in India from this source but it is produced from shark liver oil. The production of citral from lemon grass and the synthesis of Vitamin A from this should be taken up immediately in India.

Palma Rosa or Rosha Grass Oil.—Rosha grass is a perennial plant growing to a height of about 5 to 8 feet. It is grown from seeds which are generally sown in the months of June before the monsoon starts. In 4 to 5 months the grass is ready for its first cutting and distillation. The oil is distilled from the entire grass including the flowering stalk, the leaves and flowers yielding most of the oil. Rosha grass grows abundantly in Madhya Pradesh, Bombay State and is also found in Baroda, Gwalior and Indore State, but it is reported that no attempt has been made in any of these States to distill the oil. Puran Singh

introduced the grass into the Punjab many years ago and started a model plantation on a cottage industry basis. The grass is said to be known in India from ancient times and until recently India was the only source of supply of this oil. The production of the oil is estimated by Schimmel at about 40 to 50 tons per annum, but this appears to be an exaggerated figure. Palma rosa oil used to be exported to Europe where it was valued on account of its principal aromatic constituent, geraniol, which is present in the oil to the extent of 90 to 95 per cent. During recent years Indian manufacturers of soaps and toilet articles have also started to use the oil in the blending of their perfumes. No statistical figures are available but it is certain that India holds an important position in the supply of palma rosa oil; it is therefore essential that its large scale propagation on scientific lines is encouraged and only best variety of grass is grown.

Attars.—Attars are blends of flower oils in sandalwood oil in varying proportions and the proportion of the flower oil in the attar determines the quality of the attar. It is very ancient art which has been in vogue in India from times immemorial. The main centres of production of attars in India are in Uttar Pradesh, Kanauj producing several lakhs of Rupees worth of attars every year. There are no large scale industries for this purpose and attar production is mainly carried out on cottage industry scale. With the production of cheap synthetic perfumes closely resembling attar, this industry is gradually dying out as the former are being used now to blend the sandalwood oil, for the production of attars. This industry is rapidly dying out as the taste of Indian people is tending more and more toward western blends. Thirty different attars are made in Kanauj but the most common are henna, jasmine, kewda, mitti, moghara or bela and rose.

Henna Attar.—This is not a flower attar but is a blend of perfume produced from about twelve volatile oils and aromatic gums and resins. Its exact formula is a closely guarded secret and each manufacturer has his own formula for this attar. Nearly 12,000 lb. of it is produced annually in India the price varying from Rs. 30 to Rs. 50 per lb.

Jasmine Attar.—A number of species of Jasmine grow in India.

1. *Jasminum auriculatum* Vahl. "Juhi".
2. *Jasminum grandiflorum* Linn. "Chameli".
3. *Jasminum angustifolium* Vahl. "Mallica".
4. *Jasminum humile* Linn. "Malati".
5. *Jasminum officinale* Linn. "Chamba".
6. *Jasminum pubescens* Willd. "Kund-phul".

Pure jasmine oil is not produced but attar is prepared in different places in Uttar Pradesh such as Kanauj, Jaunpur, Ghazipur and Skindarpur. The out-turn of jasmine flowers is estimated in Kanauj and Jaunpur at 18,000 lb. and at Skindarpur nearly 27,000 lb. per annum. In addition to the preparation of attar at these places, large quantities of jasmine scented fixed oils, mostly from til seeds (sesame) are also prepared at these places. There are two seasons

for these flowers, first a short season for a month in early summer and then from July to October. The price of these attar varies from Rs. 20/- to Rs. 50/- per lb. In India jasmine 'concrete' and 'absolutes' should be prepared by enfleurage method as in Grasse in South France. The price of 'concrete' is Rs. 750 per lb. and of 'absolute', Rs. 2,500 per lb. and there are great possibilities for this industry in India. From a variety of jasmine called the moghra or bella variety an attar known as moghara or bela attar is produced. The moghara or the bela flower has different aroma to that of jasmine. The production of the moghara variety is very large in Uttar Pradesh but its attar is prepared to a limited scale as it has a very restricted demand.

Kewda Attar.—Kewda or screwpine (*Pandanus odoratissimus*) grows in large quantities in Orissa, in the coastal districts and in Ganjam. The bulk of the flowers are used as offering in the temples or by ladies for wearing in hair. The season for the flowers lasts from April to November. This attar is mostly produced in Uttar Pradesh as a cottage industry and the distillers in Kanauj set up their stills in the season in the flowering districts. It is produced in very limited quantities.

Mitti Attar.—This attar is a speciality of Kanauj and is produced from Kanauj clay after giving it special treatments. The treated clay is mixed with water and distillate from this is condensed in Sandalwood oil and is allowed to mature for months before used. In this case also the process of making is a guarded secret with individual manufacturers. This attar has very limited sale and is restricted to clients having acquired special taste for it.

Rose Attar.—It is produced at Ghazipur and Barwana in Uttar Pradesh. It is distilled from flowers and calyxes and is very greatly prized in India. Attars from other flowers are also produced in limited quantities, i.e., maulasari or bokul flowers (*Mimusops elengi*) yield maulsari attar, chamak and narcissus (nargis) are distilled for the preparation of their particular attars.

There is not much demand for these attars now and these are, therefore, produced only in small quantities.

Aromatic Chemicals

The synthetic perfume industry has made tremendous advances in the past quarter of a century and the major field of development has been in the isolation of many compounds from essential oils of which they form a major constituent. For example the geraniol which has a rose odour, is obtained from citronella oil (which itself is not valued to the same extent because of the presence of other ingredients) and linalool from rose wood oil. For the production of perfumery isolates we are dependant largely on natural sources. Another phase of the development involves the production of other valuable perfumery compounds which are either present in very small quantities in the oil or because of the high cost of the natural oil in which they occur. Many of these chemicals have been synthesised from naturally occurring materials or from synthetic sources. Phenyl ethyl alcohol present in the expensive rose oil has been synthesised from coal tar

products and terpineol from the naturally occurring pinene. A third source of perfumery materials are certain odorous compounds which do not occur in nature but have been discovered as a result of painstaking research carried by chemists from time to time. Examples of this type are artificial nitro musks, the three important being: (i) Musk Ambrette (ii) Musk Ketone (iii) Musk Xylene. All are produced from xylenes which are obtained from crude benzol. The ethers derived from phthalic anhydrides are important fixatives in perfumery industry.

In modern perfumes the essential oils occurring in nature and aromatic chemicals go hand in hand. Today aromatic chemicals can be produced to give a scent typically characteristic of leaf, flower or fruit or an aroma which may even baffle the highly developed olfactory sense of an essential oil expert. In the cheap synthetic perfumes of today and also in the manufacture of flavouring essences, the aromatic chemicals play a very important role due largely to the intensity of their odour.

THE IMPORTANT ISOLATES USED IN THE PERFUMERY ARE:

1. Cinnamic aldehyde from cassia oil.
2. Citronellal from citronella oil.
3. Citral from lemongrass oil.
4. Eugenol from cloves or cinnamon leaf oil.
5. Geraniol from citronella or palmarosa oil.
6. Linalool and linalyl acetate from linaloe oil.
7. Rhodinol from geranium oil.
8. Santalol from sandalwood oil.
9. Vetiverol from khus oil.

With the exception of citronella oil, all the other oils are available to certain extent in India and therefore, it should be possible to start the production of most of the above isolates in India.

It would be interesting to compare the value of the isolates with those of the oils from which they are derived. For instance, Indian lemon grass oil before the war fetched, a price of Re. 1/- per lb., whilst its isolate 'citral pure' was quoted in Europe at Rs. 8 per lb. (13 sh.). Similarly the Indian palmarosa oil was sold at Rs. 5/- per lb., whereas the geraniol derived from it was quoted in Europe at Rs. 16/- per lb. (24 sh.). These are only the most important isolates of these oils; there are also other isolates present in these oils in smaller proportions and these have also a commercial value. It will be obvious that India suffers an enormous loss by the export of these oils and importing from abroad their isolates at exceedingly high prices.

The aromatic chemicals synthesised from coal tar derivatives and other sources are in large demand in India and fifty lacs of rupees worth of these were imported annually before the Second World War. The consumption of these has increased considerably with a consequent heavy increase in imports. The important compounds at present being imported are:

Amyl acetate pure, Amyl cinnamic aldehyde alpha, Benzyl acetate, Benzaldehyde free from chlorine, Benzyl alcohol, Benzyl benzoate, Benzyl formate, Benzophenone, Benzyl propionate, Benzyl salicylate, Citronellol pure, Coumarin crystals, Diphenyl oxide, Eugenol, Geraniol pure, Gerniol for soap, Geranyl acetate, Heliotropin, Hydroxycitronellal, Indol, Ionone 100 per cent., Ionone alpha, Isoeugenol, Linalol pure, Linalyl acetate, Methyl ionone, Musk ambrette, Musk ketone, Musk xybol, Nerolin, Yara Yara, Phenyl ethyl alcohol, Rhodinol, Skatol, Terpeneol, Vanillin.

With the stepping up of steel production in India, the distillation of coal for the production of coke is also being increased. It is hoped that in the near future India will have a well established industry for the preparation of coal tar products. The carbonisation of good quality coke, produces considerable amount of combustible gases which carry with them other compounds such as ammonia, tar and benzol. It is estimated that one ton of coal yields, $2\frac{1}{2}$ gallons of crude benzol and 5 gallons of tar and these can be converted into the aromatic chemicals for which there is a large demand in soap, cosmetic and allied industries.

At present the aromatic chemicals are not being prepared in any substantial quantity in India but steps will no doubt be taken to start the manufacture of these in the production of coke.

Consumption of Essential Oils in India

The important users of essential oils and aromatic chemicals in India at present are: (1) The Soap and Cosmetic Industry (2) The Pharmaceutical Industry (3) Confectioners and Aerated Water Makers (4) Manufacturers of Attars, Perfumes, Tobacco and Agarbathies.

Soap Industry.—The production of soap in India is estimated at more than 90,000 tons per annum including 6,000 tons per annum of toilet soap. Even the village soap maker using cold process on a cottage scale, perfumes the soap to mask its fatty odour. The percentage of perfume used in ordinary laundry soap may be taken at about $\frac{1}{2}$ per cent by weight; for perfuming therefore 80,000 tons of washing soap, 400 tons or about 9,00,000 lb. of essential oils and or perfumes are required, the value of which at even a low price of Rs. 2/- per lb. comes to 18 lakhs. In toilet soap, the percentage of perfume used is much higher, and is in the neighbourhood of $1\frac{1}{2}$ per cent. On a production of 6,000 tons of toilet soap per annum, therefore, nearly 90 tons or 2,00,000 lb. of perfumes would be used. The toilet soap perfumes are much more expensive than those used for laundry soaps and estimating their cost at an average of Rs. 7/- per lb., the value of perfumes used in toilet soaps will be over Rs. 14 lakhs. The laundry and toilet soaps, therefore, between them, consume over Rs. 30 lakhs worth of perfumes, the bulk of which is imported from abroad. If the soap industry's progress in India is maintained at the present rate, it is reasonable to expect that in the course of a few decades the consumption of essential oils and aromatic chemicals in this industry will double itself. If steps are not taken to develop the essential oil and aromatic chemicals industry in India, it would mean a still larger depen-

dence on imported perfumes. The manufacture of cosmetics such as hair oils, creams, powders, etc. also needs fairly large quantities of perfumes. Hair oils are popular throughout India and as they are mostly made from crude vegetable or mineral oils, the percentage of perfumes used in them is much greater than even in toilet soaps, probably to the value of Rs. 15 lakhs per annum. There is thus a great scope for development of these perfumes.

Pharmaceuticals.—The Pharmaceutical Industry is another large consumer of essential oils. On a very conservative basis this industry consumes not less than 60,000 lbs. of essential oils per annum, the value of which may be estimated at Rs. 3 lakhs. This figure does not take into account the requirements of dispensing chemists all over India whose consumption of essential oils will be worth another few lakhs per annum, making a total of Rs. 5 lakhs.

Confectionary and Aerated Water Makers.—The value of flavour essences for aerated waters and confectioners imported into India can be estimated to be at Rs. 10 lakhs per annum. The important flavouring essences used are ginger, lemon, orange, vanilla, pineapple, raspberry, rose, etc. These are mainly derived from essential oils.

Attar Manufacturers and Perfumers, etc.—No accurate figures of the quantity of 'attar' produced at Kanauj and other places nor their values could be obtained, but from the information obtained it is gathered that their value is well between Rs. 20 to 30 lakhs per annum. Similarly the consumption of perfumes in the manufacture of tobacco, agarbathies, incenses, etc. would add another few lakhs to the total consumption of India.

Apart from their use in perfumery, some essential oils, such as the citronella oil, form important ingredients of insect repellent preparations which are widely used as protection against insect pests. A good deal of work has been done in connection with the insect-repellent properties of essential oils, but comparatively much less work appears to have been done on their insect-attractant properties. It is well-known that certain insects are attracted by floral odours ; more detailed studies in this connection are indicated.

Resins and Balsams

These are 'hold-ups' for evanescent perfumes. Some of these may even be valuable as are various resins and balsams, many of which are widely employed as fixative perfumes' spreading agents in the manufacture of soap. Large quantities of these are daily used all over the world, particularly in the orient as incense, either alone or mixed with aromatics. No statistics are available of the quantity and value of incense used in the world, but they must be enormous. In India, even a poor man uses some of these incenses on auspicious days to perfume the air in his hut. Not only are these of daily domestic use but in the process of cremating the dead large quantities are required.

Summary

To summarise, the consumption of essential oils in India at the present time would amount to one crore of rupees per annum of which over Rs. 90 lakhs could be accounted for as follows, estimated on a very conservative basis:

1. Soap industry	....	....	Rs. 32 lakhs
2. Cosmetics	....	....	Rs. 15 lakhs
3. Pharmaceutical	....	....	Rs. 5 lakhs
4. Confectionery and aerated waters	...	...	Rs. 10 lakhs
5. Attar, perfumery, tobacco, etc.	...	...	Rs. 30 lakhs
TOTAL			Rs. 92 lakhs

This analysis clearly shows how much scope there is for development of the essential oil industry in India for which the raw material is available or can be produced by proper cultivation of the essential oil bearing plants.

Cultivation and Introduction of Exotic Aromatic Plants

Besides the study and exploration of aromatic plants growing in a state of nature in India, many an exotics of recognised pharmaceutical or perfume value need introduction and cultivation in this vast country with varying climates and soils. Infact cultivation of some important indigenous plants also needs consideration for economic commercial exploitation. This is important in view of the fact that perfume constituents of plants increase and develop better with proper cultivation. The perfumery industry can ill afford to depend on the collections from wild sources growing in scattered and far flung areas inaccessible to easy approach. It is reported that the odoriferous principles are delicately balanced and deterioration sets in almost as soon as the material has been collected for distillation. In addition to these, age and developmental stages as also the time and season when the essential oil reaches the maximum limit have also to be taken into consideration. In case of lavender, peppermint, etc. it has been found that the oil content reached a maximum immediately before the fertilization of flowers. At this stage there was a notable consumption of oil, the proportion of which decreased further as the fruits ripened. In the case of coriander it has been reported that the oil content increases with the maturity of fruit, until it starts, shedding. In order to obtain the best otto of roses, the rose petals should be collected before the sun is up and distilled immediately. This however, is not possible from the wild collections. The leaves of Japanes mint (*Mentha arvensis*) are recommended to be harvested when the dew has disappeared from the leaves in the morning. Apart from these considerations, cultivation decreases the cost and facilitates the collection. It has been said that fragrant flowers flourish in warm climate but the more delicate perfumes are derived from plants having a colder habitat. India is endowed with all conceivable climates, seasons and soils and there is no reason why most of these commercial perfume bearing plants could not be cultivated in this country. Lavender and peppermint which flourish at Mitcham and Hitchin in England are unsurpassed so far. With

modern advances in the science of breeding and selection, the development of requisite aromas and the greater yield of essential oils are matters which deserve careful attention.

As already stated cultivation of some plants has been taken up in different States in India and the interest has been initiated by the Essential Oil Committee of Council of Scientific and Industrial Research by guiding and developing the industry which was otherwise deteriorating rapidly.

The present authors have carried out experimental cultivation of Lavender, English Dill, Japanese Mint, American wormseed and pennyroyal in Jammu and Kashmir with the following results. The cultivation is being extended.

	Percentage Yield of Oil	B. P. Standard Percent
<i>Anethum graveolens</i>	.... 2.1	2.4
Carvone	.... 45.9	43.63
<i>Chenopodium</i>	.... 1.2	0.6 to 1.0
Ascaridole	.... 70.0	65.0
<i>Lavender</i>	.... 2.4	0.8 to 1.7
Linalyl acetate	.... 24.8	7 to 14
<i>Mentha arvensis</i>	.... 2.1	0.8 to 1.7
Menthol	.... 70.1	70 to 80

A number of essential oil bearing plants grow in a state of nature in the north-western Himalayas. A preliminary survey revealed 100 such plants. These may be divided into three groups. The first group consists of well-known plants whose essential oil content compares well with that of plants grown in other parts of the world. These can be taken up for commercial exploitation immediately. The second group includes local plants yielding essential oil; these plants either do not occur elsewhere or they have not been exploited so far. The third group consists of plants which give small yield of essential oil, but whose essential oil content can be increased by proper cultivation. Exotic plants, such as lavender, mint and pennyroyal, can be easily cultivated in parts of northern India. If cultivated on a commercial scale these will not only meet the requirements of Indian soap and cosmetic industries but may become available for export.

Essential Oil Bearing Plants Growing in India

NAME OF THE PLANT	PERCENTAGE YIELD OF OIL	
	LOCAL SPECIMEN	FOREIGN SPECIMEN
GROUP 1.		
<i>Mentha sylvestris</i>	1.20	0.90 (Cyprus)
<i>Mentha arvensis</i>	1.45	1.05 (Japanese)
<i>Mentha piperita</i>	0.71	0.50 to 1.00 (U.K.) 1.60 to 1.70 (Russia)
<i>Mentha pulegium</i>	2.30	0.60 — 1.70
<i>Lavandula officinalis</i>	2.40 — 3.00	0.80 — 1.70
<i>Thymus serpyllum</i>	0.72	0.15 — 0.60
<i>Acorus calamus</i>	3.10	1.50 — 3.50

NAME OF THE PLANT	PERCENTAGE YIELD OF OIL	
	LOCAL SPECIMEN	FOREIGN SPECIMEN
<i>Hyssopus officinalis</i>	0.70	0.30 — 0.90
<i>Angelica glauca</i>	1.30	0.35 — 1.00
<i>Elsholtzia cristata</i>	0.93	2.00
<i>Juniperus communis</i>	0.77	1.00 — 1.50
<i>Zanthoxylum alatum</i>	2.01	3.70
<i>Aegle marmelos</i>	0.54	0.60
<i>Archangelica officinalis</i> (roots)	0.80	—
<i>Archangelica officinalis</i> (seeds)	3.80	0.30 — 0.90
<i>Carum carvi</i>	4.30 — 8.50	3.50 — 6.00

GROUP 2.

<i>Inula racemosa</i>	0.38	—
<i>Skimmia laureola</i>	0.49	—
<i>Saussurea lappa</i>	1.22	—
<i>Nepeta ciliaris</i>	0.54	—
<i>Cinnamomum tamala</i>	1.20	—
<i>Chaerophyllum villosum</i>	0.98	—
<i>Salvia moorcroftiana</i>	0.25	—
<i>S. glutioza</i>	0.32	—
<i>S. dumitorum</i>	0.34	—
<i>S. hians</i>	0.24	—
<i>Heracleum cachemericum</i>	0.80	—
<i>Elsholtzia densa</i>	0.98	—
<i>Ferula jaeschkeana</i> (roots)	1.20	—
<i>Ferula jaeschkeana</i> (seeds)	3.80	—
<i>Artemisia dracunculus</i>	0.70	—
<i>Juniperus macropoda</i>	3.32	—
<i>Prangos pabularia</i>	0.65	—
<i>Senecio jacquemontianus</i>	1.20	—

GROUP 3.

<i>Nepeta ruderalis</i>
<i>N. elliptica</i>
<i>Iris kashmiriana</i>
<i>I. kumaonensis</i>
<i>Betula utilis</i>
<i>Plectranthus rugosus</i>
<i>Artemisia laciniata</i>
<i>A. grata</i>
<i>A. parviflora</i>
<i>A. amygdalina</i>
<i>Anthemis nobilis</i>
<i>Origanum vulgare</i>
<i>Achillea millefolium</i>

Aromatics, enjoy a considerable trade in the world markets. Latest available figures show that in 1935 total imports of essential oils and synthetic odorants to 19 principal countries amounted in value to above 100 million rupees (Schimmel & Co., 1938, Ann. Rep., 138).

	Rs.
Great Britain	2,36,00,000
United States	1,72,00,000
Scandinavian countries	30,00,000
India	14,00,000
Spain	22,00,000
France	83,00,000
Holland	45,00,000
Germany	1,35,00,000
China	17,00,000
Argentina	22,00,000
Italy	47,00,000
Japan	23,00,000
Belgium	29,00,000
Switzerland	37,00,000
Australia	23,00,000
Czechoslovakia	18,00,000
Brazil (1934)	31,00,000
Egypt	5,00,000
Union of South Africa	8,00,000

India's share in the world trade of essential oils is significant, but hardly commensurate with her resources or potentialities. During the two years preceding World War II she imported essential oils worth about Rs. 17,00,000 annually and her average annual exports amounted to about Rs. 25,00,000. During the same period the average annual exports of essential oil bearing raw material (mostly spices) amounted to about 17,000 tons, valued at about Rs. 78,00,000 (Narielwala and Rakshit). A vast improvement in the existing state of affairs is not only possible but also can be easily effected.

France is one of the most important countries where cultivation of aromatic plants and the distillation of essential oils for perfumery has been highly developed. The manufacture of essential oils in Grasse (South France) her most important centre of perfumery, bought and worked up for an average about 62,50,000 lb. of flowers and leaves.

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B. LICHENS : THEIR MEDICINAL USES

Although lichens constitute a large group of plants, adequate detailed knowledge is not available about these symbiotic organisms. Structurally the lichens are composed of algal cells enveloped by the mycellium of the fungus forming a felted mass. Some of them are useful as fodder for cattle. It is well-known that caribou or reindeer in the arctic live on moss of lichens. Others, such as manna, form food for man. Many others are employed in dyeing and perfumery industries. This group of plants is not regarded as a serious menace to livestock as far as poisoning is concerned, yet a number of species of the *Parmelia* and *Cetraria* have been reported in foreign countries to have produced untoward effects. *Parmelia molliuscula* has been said to be poisonous to sheep and cattle, chief symptoms being lack of co-ordination of the hind limbs. In more severe cases the animal lies down paralysed not being able to move either its front or hind limbs. Lichens containing derivatives of pulvinic acid have been used in northern European countries to poison wolves by stuffing them into the bait. The chemical components isolated from them, when tested on animals produced respiratory difficulties leading to death. Pulvinic dilactone in particular, has a digitalis like cardiac effect and is also potent against *Trypanosoma equiperdum*. Recently Stoll has observed that pulvinic acid is a powerful anti-bacterial agent *in vitro*.

Cetraria islandica (Iceland moss) has long been used as an emergency food by the Lapps and Ice-landers after getting rid of bitterness by maceration in water or dilute sodium carbonate. In Scandinavia it has been used in the treatment of pulmonary disease, as far back as the seventeenth century. Lichens are also used in the preparation of certain dyes and certain antibiotics have been prepared from them. Some of the foreign lichens such as *Evernia prunastri* Ach. especially when collected from oak trees, form one of the indispensable raw materials in the perfume industry. The oak moss or *Mousse de chene* as it is called, when extracted with volatile solvents, yields a product consisting largely of chlorophyll together with resin and a volatile oil. The colourless solute obtained from this is highly esteemed in perfumery. Atranorin is used as a diluent for perfumes. It will thus be seen that lichens constitute a valuable natural material in many ways. This group is fairly widely distributed in India with its varied climatic zones. The chemical composition of lichens is peculiar, highly variable and complex. Important among their components are lichen acids to which medicinal properties are attributed. Sheshadri and his co-workers have pointed out that lichens of India form an unexplored field and that even their systematic botany has not been sufficiently worked out.

CHEMISTRY.—The chemical investigations of Indian lichens carried out by Sheshadri and his co-workers are summarised below:

Roccella.—The vast wealth of lichen flora, found in the hill forests of India as also in the coastal regions, remained unexplored till recent years. Seshadri

and co-workers began their studies with a lichen (found commonly on the east coast of India) occurring abundantly in Waltair and neighbouring areas and identified as *Roccella montagnei*. It is found on cashew nut, mango, pongamia, tamarind and banyan trees and is easy to collect. This lichen was well-known as the source of dyestuffs such as archil, cudbear and litmus. Its chemistry had, therefore, been studied earlier. Detailed investigation of the Indian samples collected in different seasons gave interesting new information. The important chemical components already worked out are erythrin, erythritol, lecanoric acid and roccellic acid. There was, however, considerable variation in their relative proportions depending upon the season and time of year when collection was made. A new compound was also isolated and because of its phenolic properties it was named montagnetol. Analytical and degradative studies showed that it is the erythrityl ester of orsellinic acid which occurs both in the dextro and racemic forms. Its isolation was considered important as it represented the sole example of the occurrence of the depside unit orsellinic acid. Previous records indicated its presence only in the form of di- and polydepsides; the presence of orchinol itself in lichens had been previously noted. It has thus been shown that orsellinic acid is the primary unit, but it is unstable and gets stabilized in the form of di- and tridepsides; otherwise it undergoes decarboxylation to form orcinol. In the case of montagnetol, this unit is stabilized by esterification with the polyhydric alcohol erythritol. As a result of this work the constitution of erythrin which was unsettled till then became clear. It was proved to be the erythrityl ester of lecanoric acid. Another interesting feature of this leafy lichen, noted at a later stage, was the presence of considerable quantities of β -carotene as much as 40 mg./100 g. This is an important finding in view of the fact that this lichen is a good fodder and can provide adequate supply of this precursor of vitamin A.

Among the components of *R. montagnei*, erythrin, montagnetol and lecanoric acid can be readily converted into litmus. Roccellic acid derivatives have been studied by Barry and his co-workers who have found them to be active anti-bacterial agents.

Parmelia.—*Parmelia abessinica* belongs to the crustaceous type of lichens. It is readily available in large quantities in the market in South Deccan Plateau, particularly in Bellary. In that area it is largely used as food material and as condiment. This lichen has not been examined before and a detailed study showed that it contains atranorin, lecanoric acid and salazinic acid. Another lichen of genus *Parmelia*, which was identified as *Parmelia tinctorum*, was also examined. Foreign samples of this lichen had been investigated earlier by Hesse as well as by Asahina and the presence of atranorin and lecanoric acid was reported in it. A remarkable feature of this lichen is that it sometimes contains a very high percentage of lecanoric acid and its secretion may account for the distintegration of rocks and monuments made of stone on which it grows. A sample of this type which was obtained from the famous Java monument at Borabudur contained as much as 20.3 per cent. of lecanoric acid. Some samples obtained from Sravanabelagola in Mysore, contained 5 to 6 per cent. of this acid. The first Indian sample of this lichen was collected from Coorg from sandalwood trees, and

it was found to contain besides atranorin and lecanoric acid, nor-strictic acid also. On the other hand a sample which was later obtained from Chaubattia in the Himalayas and also from Mysore area, was found to contain besides atranorin and lecanoric acid the depsidone, salazinic acid. Since morphological characteristics are just the same and also since biogenetically atranorin, salazinic acid and nor-strictic acid are closely related, these Indian samples may be considered to be different chemical strains of *P. tinctorum* and not as different species.

Parmelia abessinica and *P. tinctorum* contain lecanoric acid which is an excellent material for the manufacture of litmus. Atranorin has been recently reported to possess antibiotic properties and is also toxic to fish. Another lichen belonging to this species *P. quercina* Wain collected from Marudamalai Hill in South India was chemically examined. Besides atranorin and lecanoric acid it contained a third component, named lichexanthone, the only xanthone derivative so far reported to be occurring in lichens. Four other subspecies, *P. scredica* Nyl, *P. manshurica* Asahina, *P. hyproysalae* Wain and *P. sublaevigata* Nyl, were also found to contain lecanoric acid and atranorin in varying proportions.

Ramalina.—Damage to sandal trees on the Simhachalam Hills near Waltair due to lichens was reported in 1946. The lichen which was predominant on these trees was *Ramalina tayloriana*. It grew profusely on the tender, growing parts of the trees, and it appeared that by means of its hold-fast, it injured the sandalwood tree by damaging its tender, growing parts. This lichen was found to contain dusnic acid, sekikaic acid and *d*-arabitol. Of these the first two are toxic to fish and it seemed possible that besides the physical injury caused by the penetration of the plant by the lichen the acids secreted by it could also have a phytocidal effect. These compounds were reported to have antibacterial properties, usnic acid being effective against *Staphylococcus aureus* in a concentration of 1/160,000 and sekikaic acid in a concentration of 1/80,000. Particular mention may be made here of the effectiveness of usnic acid in high dilutions against tubercle bacillus. Two other lichens belonging to this family were collected from Nainital and were identified as *R. calicaris* and *R. sinensis*. The former contained usnic acid, sekikaic acid and *d*-arabitol while the latter contained only usnic acid and *d*-arabitol.

Teloschistes.—Lichens containing hydroxyanthraquinone pigments also occur in India. Along with *Ramalina tayloriana* (in the Simhachalam Hills) was another lichen identified as *Teloschistes flavicans*. Though this lichen was investigated earlier by Zoff who reported the presence of physcion and an unidentified colourless substance, the study of the Indian sample gave interesting results. Besides the above two components, it yields a new substance which has been named teloschistin. Its constitution has been established as 2-hydroxymethyl 4:5-dihydroxy-7-methoxy-anthraquinone and shown to be closely related to physcion, the difference being the *w*-hydroxyle group. There is considerable interest in the isolation of this substance because it is closely related to a mould product, *w*-hydroxyemodin, which was isolated from the mould, *Penicillium cyclopium*, by Raistrick *et al* and from *P. citreo-roseum* by Posternak who gave

it the name of citreorosein. By partial methylation of it, Raistrick *et al* obtained its 7-methyl ether which is found to be identical with teloschistin. The isometric 4-methyl ether of w-hydroxy-emodin was also isolated by Hind and called by him carvinolin, and by Posternak who called it roseopurpurin. The occurrence of teloschistin in the Indian sample of *T. flavicans* lends further support to the view that the fungal portion of the fungus-alga symbiont, is responsible for the synthesis of many of the lichen constituents. Further, various plant drugs in use for a long time are known to contain anthraquinone derivatives and it is possible that teloschistin also possesses such drug value.

Caloplaca.—Recently, a small quantity of a deeply coloured lichen was collected from the rocks at Srinagar in Kashmir, and it has been identified as belonging to a variety of *Caloplaca elegans*. This lichen was found to contain physcion (0.7 per cent.) due to which the lichen is deeply coloured. The yield of this substance is comparable with that from *T. flavicans*.

Usnea.—Members of the family Usneaceae seem to be widely distributed in India. A sample received from Coorg growing on Sandal trees was identified as *Usnea japonica*. Previously this lichen was known to occur only in Japan and Formosa, and Asahina recorded the isolation of usnic and stictic acids from it. The examination of the Indian sample revealed besides the above two acids, the presence of barnatolic acid. This lichen acid deserves further study in regard to its chemical and antibiotic properties. Since the Japanese and Formosan samples did not contain this acid, the Indian sample of *U. japonica* should be considered as a different chemical strain.

Similar differences in the chemical constituents could be noted in samples of *Usnea orientalis*, obtained from (1) Chaubattia (Himalayas) and from (2) Kodaikanal in south India. There is no earlier record of the chemical study of this lichen but Prof. Asathina considers that the samples (1) is identical with *U. orientalis* occurring in Japan. The difference between the two strains lies in that in (1) there is salazinic acid whereas in (2) there is the related compound, stictic acid. Both of them contain usnic acid also. On a re-examination, the sample of *U. orientalis* from Kodaikanal showed the presence of a fatty acid, namely caperatic acid. This also occurs in certain fungi and has been found to be feebly active against *Staphylococcus aureus* (Terashima).

Usnea longissima is a long fibrous lichen available in large quantities in Simla Hills. It is soft and is used locally for filling cushions. This lichen is reported to have been in use in China for medicinal purposes, especially as an expectorant and in the treatment of ulcers. Samples of this lichen from Japan as well as from Europe were investigated by Asahina and Tukamoto who reported the presence of usnic and barbatic acids as major components and an unidentified substance melting at 211°C. as the minor one. The Indian sample of *U. longissima* yielded, besides usnic and barbatic acids, a rabinol also but the compound melting at 211°C could not be obtained. An important feature of this lichen is that it gives high yield of usnic acid (3-4 per cent.)

Usnic acid has been examined by a number of workers for its antibiotic properties. Barbatic acid was examined recently in the Antibiotic Research Centre, Bombay, and was found to be active against *Diplococcus pneumoniae* and *Streptococcus viridans*. But it was also found to have haemolytic activity.^{46c}

Usnea aspera Wain. and *U. stirtoniana* Zahlbr. collected from Devicolam Hills on chemical examination revealed the presence of psoromic acid and stiotic acid respectively. Usnic acid was also present in both of them.

Lobaria isidiosa Wain collected from Darjeeling contains the lephoric acid, the only phenanthrene quinone pigment so far reported to be occurring in nature. It was first isolated by Kogl from the fungus *Thelephora palmata* Scop.

Loppraria.—Lichens belonging to this species contain the pulvinic acid group of compounds having a C₁₈ skeleton. Two subspecies of Indian origin have been investigated. *L. flava* (Schreb.) Ach. collected from Kodaikanal has been found to contain pinsatric acid. *L. citrina* Schaer collected from Simla Hills has given a new member of this series, now given the name leprapinic acid. Its structure has been shown by degradation and synthesis to be 2-methoxy pulvinic acid methyl ester. By applying an improved method, the structure of pinastric acid has been corrected and shown to be 4-methoxy pulvinic acid, the methoxyl group substituting the phenyl ring near the ester group.

From what has been said it will be observed that lichens of India form still an inadequately explored region. A detailed study of these may be of value from medicinal and economic points of view.

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C. MEDICINAL FERNS

Ferns (Filicales) comprise the largest group of Pteridophyta, also known as vascular cryptogams and at present about 4,000 species are known. These are generally most abundant in shady tropical forests although they are found in temperate regions also. Ferns are highest type of 'flowerless plants', having well-developed vascular and tegumentary systems, and exhibiting a complete differentiation into root, stem and leaf. The leaves are large and compound and are known as 'fronds'. Out of the large assemblage of these highly ornamental plants, however, only some ten to twelve are of interest from the economic or medicinal points of view. A very large number is grown as rocky and foliage plants but none are being cultivated for edible or medicinal purposes.

Asplenium ensiforme Wall. yields a bright red dye which stains the mounting paper. The young underground stems and young fronds have been reported to be used as food by the hill tribes in India not to a very large extent. The young fronds of *Asplenium esculentum* are regularly offered for sale in a number of hill stations in India for edible purposes. In Sikkim, the centre of the stems of the tree ferns are often used as food. Several ferns are employed medicinally but the merits of the male ferns do not appear to have been known to the practitioners of indigenous medicine, although this is one of the most plentiful species growing in abundance on the hills at altitudes ranging from 4,000 to 10,000 ft. above sea level. The various species of *Adiantum* are, however, extensively employed medicinally in the indigenous medicine, the most common being seen in the drug shops is *A. venustum*. Other species are also used in the treatment of skin diseases and in fevers, etc.

Polypodium vulgare (vern. *Bifay*) is used as an alterative. Among other ferns, *Actiniopteris dichotoma* is used in Goa as alterative in prolonged malarious fevers; *Asplenium fibratum* is said to be given in Garhwal as a remedy for snake bite. Very little work has been reported in India on the ferns. Even in foreign countries this group has not been extensively investigated. References to the supposed or actual toxic properties of some of the ferns, however, are occasionally found in literature. Handa *et al* (1955) investigated some ten species of *Dryopteris* met in the Western Himalayas and found the active principle filicin in their rhizomes. According to Pammel (1911), Greshoff and others have reported the presence of hydrocyanic acid in a number of ferns especially when these are young. He also states that several species of *Gleichenia* contain saponin. Several foreign species of *Aspidium*, *Dryopteris*, *Pteridium*, *Adiantum*, *Davallia*, *Osmunda*, etc. are known to possess poisonous properties but nothing is known of the corresponding Indian representative of these genera. The medicinal and poisonous properties of some of the important Indian species of ferns are discussed below :

1. *ADIANTUM AETHIOPICUM* Linn. syn. *A. emarginatum* Bedd. This fern is found in N. Kanara, Nilgiris, and Pulneys at higher elevations. Infusion of leaves is used as emollient in coughs and diseases of the chest.

2. *A. CAPILLUS-VENERIS* Linn. (H.—*Hansraj* ; Kash.—*Dumtulli*). The fern is found in Madras and Bombay States at altitudes upto 5,000 ft. and also in Northern India.

3. *A. CAUDATUM* Linn. (Sans.—*Mayurashikha* ; P.—*Adhsarita-ka-jari*). It is found throughout India, in the plains and lower slopes of hills. Fronds are used externally for skin disease and for diabetes, cough and fever.

4. *A. FLABELLULATUM* Linn. This plant is found in Nepal, Assam, Khasia and Sylhet. The herb is used medicinally in cough.

5. *A. LUNULATUM* Burn. (H.—*Kali jhant* ; Bo.—*Hansraj* ; S.—*Hansa-vati*). The plant is found in moist places throughout north India and in south India on the western side in the plains and lower slopes of the hills. The rhizomes are used in the treatment of fever and erysipelas.

6. *A. PEDATUM* Linn. (Eng.—*Canadian maiden hair*). The fern is found in N.-W. Himalayas from Kashmir to Sikkim and is used in France and North America against chronic catarrh, as demulcent expectorant, tonic, astringent and emmenagogue.

7. *A. VENUSTUM* G. Don. (H.—*Hansraj* ; Bo.—*Mubarak* ; S.—*Hansapadi* ; Tam.—*Mayirsikki*). This fern is distributed throughout the Himalayas. Fronds are considered resolvent, deobstruent, expectorant, diuretic, emmenagogue and emetic.

8. *ACTINIOPTERIS DICHOTOMA* Bedd. (Bo.—*Mayursikha* ; H.—*Morphankhi* ; S.—*Mayurshikha*). The fern is found throughout India especially in the Peninsula in dry rocky places, below elevations of 4,000 ft. It is used as an anthelmintic and styptic.

9. *ASPLENIUM ADIANTUM-NIGRUM* (Linn.) Bedd. (Eng.—*Black spleen wort*). This plant is found in western Himalayas from Kashmir to Dalhousi and Chamba at altitudes of 5,000 to 8,000 ft. It is bitter and is diuretic and laxative and considered useful in ophthalmia, diseases of spleen and jaundice. It is popularly believed to produce sterility in women.

10. *A. FALCATUM* Lam. (Bo.—*Pana* ; M.—*Nela panna maravar*). The plant is found in Madras State and western mountains. The plant is used in enlargements of the spleen, incontinence of urine, calculus, jaundice and malaria.

11. *A. RUTA-MURARIA* Linn. (Eng.—*Wall rue*). It is met with in Kashmir. This fern is used as expectorant and deobstruent. The leaves are popularly used as a cure for rickets.

12. *A. TRICHOMANES* Linn. (Tam.—*Mailakkondei*). The plant is found in the Nilgiris in the South and from Kashmir to Kumaon in the North at altitudes of 5,000 to 10,000 ft. The plant is considered laxative and expectorant and the dried fronds are smoked for treatment of colds in the head and chest.

13. *ASPIDIUM POLYMORPHUM* Wall. It is met with in the western forests of Madras State upto an altitude of 4,000 ft., in north India from Garhwal to Mishmi and Chittagong Hills. The plant is considered anthelmintic.

14. *ATHYRIUM FILIX-FEMINA* Roth. (Eng.—*Lady fern*). It is found throughout the Himalayas at 6,000 to 13,000 ft. and also in Bombay State. The rhizomes of this fern have been used as a substitute for that of the male fern. Widen *et al* (1944) reported the absence of aspidinol and albaspidin from the rhizome of *A. filix-femina*. Castel Branco (1944) obtained from 1 kg. of rhizome powder, 11.11 gm. of ether extracted material, containing 39.3 per cent. crude filicin. He also reported 7.36 per cent. tannin, 1.03 per cent. saccharose, 1.63 per cent. glucose and 1.33 per cent. levulose. It is of no value as an anthelmintic.

15. *BOTRYCHIUM* spp. Three species of Botrychium, *B. lunaria* Sw., *B. ternatum* Sw. and *B. virginianum* Sw. are found in the Himalayas from Kashmir to Sikkim. They are used as culinary and also in dysentery.

16. *CIBOTIUM BAROMETZ* Link. syn. *C. glaucum* Bedd. This fern is found in Mishmi and Assam. The rhizome is considered tonic, styptic and vermifuge.

17. *CYSTOPTERIS* spp. Two species of Cystopteris grow in India. *C. fragilis* Bernh. in north-western Himalayas, from Kashmir to Kumaon at an altitude of 10,000 to 15,000 ft. and Sikkim. *C. setosa* Bedd. in Moulmein mountains and Sikkim at 5,000 to 8,000 ft. Wherry Eigar reports a toxic glycoside in genus Cystopteris.

18. *DRYNARIA QUERCIFOLIA* J. Sm.=*Polypodium quercifolium* Linn. (S.—*Ashvakatri*; Mar.—*Ashvakatri*, *Baxsingh*, *Wandurhashingi*; Mal.—*Pannakilhan-umanavala*). It is found throughout India, in the plains or very low down in the mountains on trees or rocks. The rhizome is bitter, tonic, astringent to the bowels. It is used in typhoid fever and in the treatment of phthisis, dyspepsia and cough.

19. *DRYOPTERIS* spp. (Eng.—*Male fern*). Male fern is one of the oldest anthelmintic drugs known and has been used since ancient times for expelling tape worms from the intestines of man and animals. The vermifuge properties of the ferns have been mentioned in the works of Dioscorides, Theophrastus, Galen and Pliny. Even now it is one of the best taeniocidal drugs available and is administered in the form of a liquid extract of filix mas. It is official in most pharmacopoeias. The rhizomes and frond bases of *Dryopteris filix-mas* (Linn.) Schott, a fern indigenous to Great Britain and other European countries are official in British Pharmacopoeia for medicinal purposes. In America *D. marginalis*, A. Grey, which is found in Eastern and Central United States and North to Prince Edward Island forms the source of American male fern. *D. filix-mas* and *D. marginalis* are not indigenous to India but the allied ferns belonging to the *Dryopteris filix-mas* complex grow in a state of nature in the Himalayas. Considerable quantities of the male fern extract are annually imported into India for medicinal purposes. In order to study if any of the species of *D. filix-mas* samples growing in India can be substituted for the official ferns, Handa *et al* (1955) investigated the active principles of the following ferns:

D. odontoloma (Moore) C. Chr. occurs widely in the forests as an undergrowth throughout Kashmir. It is more common on the Northern aspect of the forests retaining moisture at altitudes of 5,000 to 8,500 ft. above sea level. It is distributed in W. Himalayas from Kashmir to Bhutan.

D. marginata (Wall.) Christ is found at places with comparatively less moisture in N.-W. Himalayas at altitudes of 5,500 to 6,500 ft.

D. blandfordii (Hope) C. Chr. is a fern of the forest floor widely distributed in the Himalayas. It is found in Kashmir and Himachal Pradesh.

D. barbigera (Moore) O. Ktze. is abundant in the alpine meadows and in the avalanche gullies in the Himalayas from Kashmir to Sikkim.

D. schimperiana (Hochst.) C. Chr. is a common fern in Mussoorie, Himalayas, growing on ridges at altitudes of 7,000 ft. and above and in the Nilgiris.

D. calcarata (Bl.) O. Ktze is found in Himalayas from Mussoorie to Sikkim. The results of analysis of various ferns are given in Table XIX. From the table it is clear that all the species of *Dryopteris* except *D. calcarata* are good substitutes for *D. filix-mas* which does not grow in India.

DRYOPTERIS DENTATA (Forsk.) C. Chr. syn. *Cyclosorus derilatus* (Forsk.) Ching. It is found wild throughout India in the plains and also on the hills upto 6,000 ft. Sen and Nandi (1950, 1951) reported that aqueous extracts of the fronds of this fern possess antibacterial activity against *Staphylococcus aureus*.

HELMINTHOSTACHYS ZEYLANICA Linn. It is found in western forests, south India upto 3,000 ft., in north India, also in Bengal plains to Assam and Cachar. According to Prain the plant is intoxicant, anodyne, used in sciatica.

LYGODIUM FLEXUOSUM Sw. syn. *L. pinnatifidum* Sw. (Mal.—*Vallipanna*). (*L. Japonicum* Sw.) These two ferns are found in north India and south India at altitudes of 2,000 to 7,000 ft. The plants are considered to have expectorant properties.

OPHIOGLOSSUM VULGATUM Linn. The plant is found in north India from Kashmir to Sikkim ascending upto an altitude of 9,000 ft. It is also found in Chota Nagpur on Parasnath Hill at 2,500 ft. and in south India. The plant is considered culinary and remedy for wounds in England and Spain.

OSMUNDA REGALIS Linn. (Eng.—*Royal fern*). The fern is found in western mountains of south India at higher elevations, in the Himalayas from Chamba to Sikkim and Bhutan, in Khasia Hills upto 4,000-6,000 ft.; in Madhya Pradesh and Bombay States. The plant is considered tonic and styptic and is used against rickets in England. Castel Branco (1944) from 1 kg. of the powdered rhizome obtained 11.42 gm. ether extractive containing 20.53 per cent. saccharose, 1.74 per cent. glucose and 0.46 per cent. levulose. The plant has no anthelmintic properties.

PLEOPELTIS LANCEOLATA Linn. This fern is found in Assam, Western Ghats of the Madras State and the Nilgiris. In Mexico a tea prepared from the fronds of this fern is used to cure itch.

PTERIDIUM AQUILINUM Kuhn syn. *Pteris aquilina* Linn. (P.—*Kakhas*; Tam.—*Parnai*; Eng.—*Bracken fern*). It is common in the Himalayas from 2,000 to 8,000 ft. and also extends to the Deccan and the Madras State. Bracken fern poisoning has occurred frequently in animals. Cattle usually do not take it but may sometimes consume in contaminated hay due to scarcity of fodder. According to W. Osebold (1952), toxicological symptoms in early cases of poisoning are evidenced by lassitude and in advanced cases by epistaxis, lacrymation, bleeding from conjunctivae and vulva and hyperpyrexia (107-8°F.) Lesions are essentially hemorrhagic with focal necrosis. Leucopenia (granulocytopenia) is followed by erythropenia and the condition resembles aplastic anaemia of man. The destructive effects on the bone marrow may be due to the toxicity of cyclic compounds or interference with haemopoietic functions. Ferns like *Equisetum* spp. produces a locomotor ataxia in horses, usually resulting from contamination of hay. General congestion, excessive fluid in the serosal cavities and degeneration of heart are seen. Apparently, the bracken plant adsorbs and then destroys thiamine, so that low thiamine and high pyruvic acid level are observed in affected horses. Casel Branco (1944) reported the absence of filicic acid in the rhizome of *P. aquilina* but the rhizome powder contains 1.87 per cent. of filicin, 5.50 per cent. tannin, 1.35 per cent. glucose and 2.5 per cent. levulose.

WOODWARDIA RADICANS Smith. The plant is found in the Himalayas from Kashmir to Bhutan at elevations ranging from 3,000 to 8,000 ft.

Chemistry.—Male fern contains a number of non-nitrogenous acids, the chief of which is complex dibasic acid, filmarone $C_{47}H_{34}O_{16}$. In addition to filmarone the male fern contains filicic acid $C_{25}H_{30}O_{12}$, aspidinol $C_{17}H_{17}O_2$, flanaspidic acid, alspaspidin, filicynyl butanone and filicinic acid. Boehm (1902-03) showed them to be derivatives of butyric acid and phloroglucinol. Aspidinol, on treatment with zinc dust and sodium hydroxide yields methylphloroglucinol, monomethyl ether and butyric acid. Filmarone occurs in the drug to the extent of above 5 per cent. It is a yellowish brown amorphous substance, having the properties of a diabasic acid. It is insoluble in water, sparingly soluble in alcohol, but soluble in most other organic solvents. Dissolved in acetone it slowly decomposes into filicic acid and filicinigrins. A similar change takes place in the official extract and gives rise to a granular deposit on keeping. Filmarone is decomposed into filicic acid, phloroglucinol or its derivatives, and butyric acid on boiling with sodium hydroxide and zinc dust. Amorphous filmarone is considered impure filicic acid or, by some, the parent substance from the decomposition of which all the other substances are formed. The drug also contains filicitannic acid, resin, and starch.

Toxicology.—Filicic acid bodies are toxic substances, their chief action in mammals being on the gastro-intestinal tract and the central nervous system. Symptoms of poisoning may occur even with moderate doses, while larger doses are dangerous. Death has occurred, especially if large doses (more than 2 drachms) of liquid extract are employed. In mild cases, headache, vertigo and

increased reflex activity are the symptoms of poisoning by these substances. In moderately severe cases, there is marked gastroenteritis, shortness of breath and sometimes amblyopia. In severe cases the central nervous system is affected, with delirium, violent muscle-cramps, syncope, tonic convulsions and coma. Death occurs from respiratory paralysis. Recovery is slow and when it takes place, there is impairment of sight in one or both eyes which is usually permanent (Chopra and Chandler, 1938).

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D. MUSHROOMS : FLESHY FUNGI

The fungi constitute a division of *Thallophyta* comprising the moulds, mildews, smuts, mushrooms, toadstools, puffballs and allied forms of which about 40,000 species have so far been described. These are readily distinguished from the algae by the absence of chlorophyll; chromatophores and starch are also wanting. They are nitrogenous in composition. Special characters in their structure, development, and life history provide further distinguishing features. The fungi range in size and form from simple unicellular microscopic cells of the yeast plant to highly organised fruiting body of mushrooms. The vegetative system consists typically of septate or unseptate filaments called hyphae, which collectively form the mycelium. They reproduce mainly by means of sexual spores which are developed in various ways, often in spore fruits of definite structure. Vegetative and asexual reproduction also occurs. The fungi are typically saprophytic or parasitic plants. Some however, are not confined to one mode of life, but may

live as parasites or as saprophytes, according to circumstances. A large number of the diseases of plants are due to the attacks of parasitic fungi. Fungi are associated with diseases of plants and animals. Whetzel (1918) refers to the earliest records of plant diseases observed in the days before 500 B.C. Information regarding blightings, blastings, rusts, mildews, and smuts can be traced in the writings of Hebrew writers. From very early time fungi were looked upon as enemies of man. These, however, have a useful role in human activity also.

Toxicological Aspects.—Chopra *et al* (1949) report that the fungi produce deleterious effects in many ways, viz.:

(a) FUNGI LIVING ON SKIN AND MUCOUS MEMBRANES.—Some of the fungi live on the skin and mucous membranes of man and animals, and cause various diseases, e.g., ringworm, thrush, etc.

(b) FUNGI ATTACKING FOODSTUFFS.—Under this are included (1) Smuts and (2) Rusts, both attacking cereals, etc. (3) Ergot (*Claviceps purpurea* Tulasne), which grows on rye and produces highly poisonous substances. (4) Moulds affecting food-stuffs.

From the utility point of view, the fungi are of immense importance in maintaining the fertility of the soil. They are responsible for directly breaking down all kinds of dead organic matter by biochemical processes until their constituent elements such as carbon dioxide, ammonia, etc. are returned to the economy of nature so that the synthetic cycle may start again. The fixation of nitrogen in the soil which is accomplished by some of the fungi is an important factor in modern agriculture. The fungi also play a very important role in the biochemical reaction in many industries, and without the existence of these low organisms those industries could not have flourished at all. It is because of the presence of these organisms that we succeed in producing the different alcoholic beverages, cheese, bread and various organic acids of medicinal importance. The group of moulds is also responsible for production of powerful antibiotics such as penicillin and others. Another group of fungi belongs to the 'mushroom' class. A number of these are edible, and many occurring in India are indiscriminately eaten. There are others which are poisonous. It has been reported by Bose (1940) that about 200 species of edible fungi are in existence whereas only about a dozen belong to the poisonous group. Mushrooms have been esteemed as food for centuries. Many references to them are found in ancient Greek and Roman literature. The cultivation of mushrooms, according to Rettew (1938), was made during the reign of Louis XIV (1638-1715). By the year 1707 the cultivation of mushrooms was a popular occupation and the Frenchman Tournefort published a complete description of the method of cultivation. The mushrooms industry spread from France to England and other countries. The most extensive cultivation of mushrooms is carried out in France, and McRae (1910) reported that in 1901 almost 125,000 maunds of mushrooms were sold in the central market of Paris.

In India the fungus *Morchella esculenta* (L.) Pers. is a very common food in Kashmir and the mushroom *Agaricus campestris*, the morel *Morchella esculenta* and the truffle and tuber are of frequent occurrence in the Punjab. *Volvaria*

terastius B. and Br., *Lepiota mastoides* Fr., *L. aluminos* Berk and *Psalliota campestris* are regularly eaten in some of the villages in Bengal. In India there is no cultivation of mushrooms because of the superstitious nature of our countrymen. The idea of raising truffles and other edible mushrooms on beds of dung is unfortunately repulsive for the people of our country and no attempt has yet been made to grow mushrooms on a commercial scale. These are grown to a limited extent in Agriculture College, Madras. Detailed account of the the cultivation of mushrooms has been described by Bose (1940) and Padwick (1941). The mushrooms in India are generally picked up from the field and sold or consumed as such. The nutritive quality of fungi has been questioned in recent years. The numerous analyses made of the edible fungi reveal that the composition varies for different species, and there is considerable variation in the analyses given for the same fungus probably owing to the composition varying with age and differing in different parts. A young specimen is more nutritious than an old one, the cap more nutritious than the stem. Bose (1940) reported chemical analysis of a few mushrooms reproduced in the Table XX.

From the above table it is evident that our local *Agaricus campestris* is superior to its foreign counter parts. In the amount of water they contain, fungi resemble green vegetables. The amount of nutrient matter in mushrooms is very small and these may be useful in the dietary of people who want to reduce weight. It is mainly as condiments that they are valuable. The chief value of mushrooms is that they act as appetisers giving variety and flavour to more nutritious foods. They are also rich in vitamins. According to Anderson and Fellers (*vide Sci. & Cult.*, 1943) mushrooms possess definite food values and are not a purely luxury food. Mushrooms can be satisfactorily used as a source of protein. Rats supplied with protein from these mushrooms were found to thrive well and recorded growth. Like the gliadin of wheat or the hordein of barley, mushroom protein is partially incomplete. In addition to their protein value, the type of mushrooms examined (*Sci. & Cult.*, 1943) was found to contain vitamins and important minerals, such as iron and copper. As a matter of fact, they constitute one of the best plant sources of the Vitamin B-complex and also contain vitamins B₁, C and K in appreciable quantities. It is further reported that about three and one half ounces of fresh mushrooms would provide about one-fifth of a grown up man's daily requirement of riboflavin and about one quarter of his requirement of pellagra-preventing nicotinic acid.

Quite a number of mushrooms have been used in medicine such as *Polyporus officinalis* and other species, and various species of *Lycoperdon*. A number of species are used in making surgeon's agaric (*Fungus chirurgorum*) formerly used as haemostatic, including *Lycoperdon bovista* and *Polyporus fomentarius* (Kraemer, 1916). In fact very little work has been done in India on mushrooms. An attempt is being made by workers in Drug Research Laboratory, Kashmir to carry out systematic study of the mushrooms growing in North-West Himalayan region especially Kashmir. About 125 different species have been collected so far from Gulmarg area and other places in the valley. Much difficulty is being felt in their identification. Only 20 out of the above number have been identified by

Bose. Chemical investigations of these to find out their nutritive or poisonous properties are in progress.

Edible Mushrooms Commonly Found in India

AGARICUS CAMPESTRIS Linn. The Mushrooms (S.—*Chhatrak*; Kash.—*Manskhel*; B.—*Banger chhata*; Santh.—*Ot*; Bo.—*Alombe*). Generally found in damp debris throughout India during rainy season; universally eaten fresh or dried.

AMITO PERS Kurrum.

A. OSTREATUS Jack. (Cutch & Bo.—*Phanasa-alamba*, or vulgarly *Phansamba*). Grows upon stumps of old jack fruit trees (*phanas*).

CANTHARELLUS CIBARIUS Fr. Grows in Kashmir, Peshawar, Mussoorie.

COLLYBIA ALBUMINOSA (Berk) Betch. syn. *Lepiota aluminosa* Berk (B.—*Durga chhata*). Bengal, Madhya Pradesh and Berar. Grows from inside the termites nests. It is eaten with relish.

COPRINUS COMATUS (Battara) Fr. The Mushroom (H. & Khumbi.—*Khumb*). It occurs in Punjab, Uttar Pradesh and several other parts of India. Eaten fresh or dried. Collected during rainy season.

ENTOLOMA MICROCARPUM Berk. & Broome. (B.—*Wcc-chhata*). Grows in Bengal on the surface of outer crust of termites nests; commonly eaten by villagers.

FISTULINA HEPATICA Fr. Found in Darjeeling.

HELVELLA CRISPA Fr. Common in Afghanistan.

HIRNEOLA POLYTRICHA Mont. syn. *Exidea polytricha* Mont. Belgium, Poona, Dharwar, Nidungavam, Malabar and Burma.

HYDNUM CORALLOIDES Scop. Grows in Darjeeling at 7,500 ft., Chitral (Pakistan) and Afghanistan in crevices of old tree-trunks collected during August, dried in the sun and largely used as food.

H. REPANDUM Linn. Mussoorie, Uttar Pradesh.

LACTARIUS DELLACIOSUS Fr. Sikkim.

LENTINUS SUBNUDUS Berk. Common in Bengal and Bombay. On dead branches or logs. Eaten by Kholes fresh and young.

LEPIOTA MASTOIDES Fr. Bengal.

L. PROCERA (Scop.) Sacc. Saharanpur.

LYCOPERDON sp. Puff balls. Bengal, Kashmir and many parts of western Himalayas.

MELANOGASTER DURISSIUMS Cooke. Truffle ; Grows in Simla, Kangra ; occasionally eaten.

MORCHELLA ESCULENTA Pers. The Morell (Punj.—*Guchhian*). It is a fleshy fungus which occurs in abundance in Kashmir, Chamba and many parts of northern Punjab. It appears on hills as snow melts in early spring. The fungus is dried and eaten with much relish.

PLEUROTUS CRETACEUS Massee. Peshawar, Punjab and Madhya Pradesh.

P. FIMBRIATUS Bolt. Madhya Bharat and Berar.

POLYPORUS SQUAMOSUS (Huds.) Fr. Darjeeling, 7,500 ft. Pangi, N.-W. Himalayas. On dead wood.

TRUFFLES.—Some are found in Kashmir. Badhwar collected some blackish-brown ones from the Kagan valley locally known as 'usri'. They are highly flavoured and their presence in the soil is discovered by the villagers by smell in September-October when they are said to develop the flavour best. Goats are also said to dig these out for food during grazing and eat them.

VOLVARIA DIPLASIA Berk. & Broome. (B.—*Pawal-chhata*). It is found in Bengal & Burma.

V. TERASTIUS Berk & Broome. (B.—*Poal-chhata*). It occurs in Bengal, grows on heaps of waste paddy straw. Stewart has mentioned another species as being freely eaten in the Punjab, which is known as 'Shirian' in the Jhelum and 'Batbakri' in the Kair valley. It is a thin, flat ragged-looking fungus, yellow above and with white gills below, which is found on dead trees in various parts of the Punjab and the Himalayas at altitudes of 8,000 to 8,500 ft. He also mentioned an 'underground mushroom' of doubtful species found near Multan called 'boinphal'.

Poisonous Mushrooms

So far as the poisonous mushrooms are concerned little information is available about the Indian species. Cases of fungus poisoning are not infrequently met with, particularly in the hills, but it is to be regretted that little or no attention has been paid to the subject. Even cattle are known to have died as a result of eating poisonous fungi. According to Ford (1923) there are five main types of Mushroom intoxication: (1) *Gastro-intestinal type*: Characterized by nausea, vomiting and diarrhoea. (2) *Choleriform type*: In this gastro-intestinal symptoms develop in from 10 to 15 hours followed by rapid loss of weight and strength ; mortality in this type is high. (3) *Nerve-affecting type*: The gastro-intestinal symptoms appear within 2 or 3 hours and terminate in violent convulsions, coma, delirium and often in death; antidote is atropine. (4) *Blood-dissolving type*: Characterized by abdominal distress and jaundice. Blood transfusion is suggested as the treatment of this type by Ford. (5) *Cerebral type*: Symptoms consist of exhilaration, staggering gait, disturbance of vision ; the patient soon becomes normal.

Poisonous Mushrooms Commonly Found in India

AMANITA PHALLOIDES. The death cap. It is responsible for perhaps 90 per cent. of the deaths caused by fungus poisoning in Europe, England and U.S.A. It is the most dangerous fungus known and very small quantities will cause intense suffering and often death. There are indeed, several other species of the genus that are very poisonous, e.g. *Amanita muscaria*—fly agaric—and *A. pantheriana*—warted agaric, etc. which are intensely poisonous.

HYPHOLOMA FASCICULARE (Huds.) Fr. from Darjeeling and Simla and *Lactarius vellerens* Fr. from Sikkim, are regarded as poisonous. There is also evidence on record that there exists in Bengal a fungus which closely resembles an edible form but which contains amanitine or muscarine, the poisonous principles of *Amanita muscaria* by eating which, symptoms closely resembling those of intoxication rapidly ensue. Furthermore, *mucor* has been regarded as harmful in India since ages, and the pickles and all edible stuff attacked by it are not thought fit for eating.

There are, however, some foreign fungi which are definitely reported to be poisonous:

LEPIOTA CRISTATA. Crested agaric and several other small species of *Lepiota* are regarded with suspicion and should be avoided. *Volvaria gloiocephala*—glutinous agaric and its allied mushrooms have always been regarded as poisonous, but there is recent evidence that they may be eaten without ill effects.

PSALLIOTA XANTHODERMA. Yellow staining mushroom has caused illness in some cases.

STROPHARIA SEMIGLOBATA (Batsch.) Quel. from Khasi Hills.

There are probably many more poisonous species than have actually been incriminated as poisonous, but on the whole their number may be small and, indeed, if properly cooked only a few may be dangerous. If washed in water and macerated in vinegar before cooking and if eaten with plenty of bread, there is practically no danger in most cases. But it is safe to avoid mushrooms having a powerful peppery or nauseous taste, and those with a milky juice. Some authors suggest that mushrooms having a volva or a sac, or those with pink spores are dangerous. The safest method, however is to learn to recognize the edible species and never to eat a fungus until its identity is certain. Most of the crop plants are susceptible to insect attack, and there are several fungi which are capable of leading a parasitic life on those insects, thus killing the insects at a very early stage and saving the crop plant. These fungi are of much importance in the biological control of insect pests. Human and animal life would have been seriously jeopardized if all these low organisms were not present in air and soil. In the life cycle the part played by the lower fungi in breaking down dead organic remains and returning their constituent elements to the economy of nature is of paramount importance. Various industrial processes have flourished due to the activity of several moulds. These organisms are attracting the attention of scientists

TABLE XIX
ANALYTICAL DATA OF LOCAL MALE FERNS

Species	Locality	Calcium crystals oxalate	Percentage of total ash	Percentage of acid soluble ash	Percentage of filicin in the rhizomes	Percentage of extractive with ether	Remarks
<i>Dryopteris odontoloma</i>	Various places in Kashmir.	Absent	3.1-4.2	0.32-0.87	2.1-3.1	7.9-11.7	Upto B.P. & U.S.P. Standard.
-do-	Mussoorie	-do-	3.5	0.31	2.3	9.2	-do-
<i>D. marginata</i>	Tangmarg	-do-	2.9	0.34	3.03	10.9	-do-
-do-	Mussoorie	-do-	4.1	0.6	2.1	10.7	-do-
<i>D. barbigera</i>	Gulmarg	-do-	2.3	0.12	2.1	7.71	-do-
<i>D. blandfordii</i>	Chattari	-do-	3.1	0.4	3.5	8.2	-do-
<i>D. schimperiana</i>	Mussoorie	-do-	2.8	0.24	4.4	13.3	-do-
<i>D. calcarata</i>	-do-	-do-	8.2	0.6	0.11	0.59	Not upto Standard.
B.P. 1948 Standards	—	-do-	Not more than 6%	Not more than 2%	Not less than 1.5%	—	
U.S.P. XIII Standards	—	-do-	—	Not more than 3%	-do-	—	

TABLE XX
NUTRITIVE VALUE OF EDIBLE MUSHROOMS

Name of the Species	Protein per cent.	Carbohydrate per cent.	Fat per cent.	Ash per cent.	Moisture per cent.
<i>Volvaria terastius</i>	2.28	trace	0.18	—	Analysed in dried condition
<i>Collybia albuminosa</i>	12.8	14.8	trace	—	Analysed in dried condition
<i>Agaricus campestris</i>	2.736	1.6	0.37	0.15	95.2
Puff balls	2.2	1.35	0.56	0.916	93.85
<i>Agaricus campestris</i>	0.18	0.46	0.03	—	—
According to G. Massee					
<i>Agaricus campestris</i>	2.25	4.95	0.20	—	91.30
U.S.D. Agri. Bull.					

and their biochemical reactions are a rapidly developing branch of modern research.

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PART V

COMMON BAZAR MEDICINES OF INDIA

There is a class of shopkeepers known as 'Pansaris' in all the large cities and towns in India. They deal almost exclusively in medicinal herbs, crude and refined inorganic medicinal preparations, as well as drugs of animal origin commonly used by the practitioners of indigenous medicine. These products are common house-hold remedies and hence they are in great demand. The 'Pansaris' are in this business for generations and have acquired a thorough knowledge. They have built up a reputation for selling authentic and pure drugs. A large number of ignorant persons with very little knowledge of these drugs are also carrying on a flourishing trade by selling sub-standard and spurious drugs.

A survey of the present position of the quality of these drugs available in the market was carried out by the authors. A large number of commonly used drugs were obtained with the help of Hakims and Vaidyas and manufacturing houses from different parts of India, and were subjected to chemical, botanical and pharmacognostic tests and the results were compared with standards laid down in the literature. Most of the drugs sold in the market were found to be spurious and adulterated.

There is, therefore, a very urgent need for the control of the quality of drugs used by the practitioners of indigenous medicine. As no standards have been laid down, it is difficult to state categorically whether a drug is genuine or not. While it is admittedly not possible to lay down standards for all the drugs mentioned in the literature of indigenous medicine, serious attempts should be made to find some workable standards for the most commonly used important drugs. A few drugs have been briefly described in Part V. A description of the drugs commonly sold by the 'Pansaris' all over India has also been given in this part.

Common Bazar Medicines of India

ABEL MOSCHUS ESCULENTUS Moench (see *Hibiscus esculentus* Linn.).

ABIES WEBBIANA Lindl.

VERN.—Sans., Hind. & Beng.—*Talisapatra*; Kash.—*Badar*; Garhwal—*Chili ragha*, *Morunda*; Kumaon—*Ragha*; Nepal—*Gobria sulah*; Bhutia—*Dumshing*.

This is a lofty tree growing in the Himalayan ranges. The leaves, in the form of decoction or infusion, are used in chronic bronchitis, phthisis and other pulmonary affections. There is a great deal of confusion about the vernacular name 'talisapatra' given to it. The drug dealers sell leaves and young shoots of many other plants such as *Taxus baccata* for *A. webbiana* and it is difficult to recognise the true drug on the market.

ABROMA AUGUSTA Linn. f. (see page 259).

ABRUS PRECATORIUS Linn. (see page 260).

ABUTILON INDICUM (Linn.) Sw.

VERN.—Hind.—*Kanghani, Kanghi*; Beng.—*Potari*; Bomb.—*Kangori, Kangoi*; Tam.—*Perun-tutti*; Tel.—*Tutiri-chettu*; Guz.—*Dabaki*; Cutch.—*Balbij*; Sind.—*Khapato*; Goa.—*Petari*; Malay.—*Tutta*; Kan.—*Shrimudrigida*; Sing.—*Anoda-gaha*; Burm.—*Bonkhoye*; Arab.—*Masht-ul-ghoul*; Pers.—*Darakhte-shanah*.

It is common throughout the hotter parts of India. The bark, the root, leaves and seeds of the plant have all been used in medicine. The leaves when soaked in water yield a mucilage which has been used as a diuretic and demulcent in fever and chest affections and also in gonorrhoea and urethritis. The seeds, finely powdered, can be given in doses of 1-2 drachms as a laxative and expectorant.

ACACIA ARABICA (Lam.) Willd.

VERN.—Sans.—*Vabbula*; Hind., Beng. & Punj.—*Babul, Kikar*; Bomb.—*Babhula*; Tam.—*Karu-velum*; Tel.—*Tuma*; Guz.—*Baval*; Sind.—*Babhula*; Mal.—*Babola*; Kan.—*Jali*; Arab.—*Ummughilan*; Pers.—*Khare-mughilan*.

It occurs throughout India in dry and sandy localities. The bark (Babul bark) is an excellent astringent and is largely used in the form of decoction in chronic diarrhoea. Its chief uses are as a local astringent douche in leucorrhoea and vaginal discharges, as an enema in piles and prolapse of anus, and as a gargle in foul and aphthous stomatitis. Babul bark in combination with mango bark, boiled for about half an hour in a pint of water forms a good preparation for mouth wash. The tree yields a gum which is an efficient substitute for true gum. acacia.

ACACIA CATECHU Willd.

VERN.—Sans.—*Khadira*; Hind.—*Khair, Katha*; Beng.—*Khayer*; Bomb.—*Khaderi, Khaira*; Tam.—*Wothalay*; Tel.—*Kaviri sandra*; Guz.—*Kher*; Santal.—*Khaiyar*; Assam.—*Khoira*; Uriya.—*Khoiru*; Sing.—*Ratkihiri*; Burm.—*Sha*.

Catechu is the resinous extract obtained by boiling down a decoction of wood of *A. catechu*. It occurs in dark brown masses with a very astringent taste. The lighter variety is an imported one from Malaya and Singapore and is derived from *Uncaria gambir*. It is given in diarrhoea in doses of 5-15 grains, alone or combined with cinnamon or opium. In ulceration of the gums, sore throat and toothache, a small piece of catechu made into the shape of a lozenge with cinnamon and nutmeg is sometimes useful and has been advocated by the Hindu physicians. An ointment, 1 drachm to an ounce of vaseline or lard is a good local application for ulcers.

ACALYPHA INDICA Linn.

VERN.—Sans.—*Arittamunjayrie*; Hind. & Bomb.—*Khokali*; Beng.—*Muktajuri*; Tam.—*Kuppaimeni*; Tel.—*Harita-manjiri*; Guz.—*Vanchhi kanto*; Uriya.—*Indra-maris*; Mar.—*Khokli*; Sing.—*Kupa-menya*.

It is a common shrub generally growing in waste places throughout the plains of India. The root, leaves and young shoots are used medicinally. It is a favourite remedy in chronic bronchitis and consumption. One drachm of the expressed juice of the leaves should be given to children. An infusion of the root acts as a cathartic. The juice from fresh leaves may be employed in scabies and other skin diseases, and with lime and onion, it is a good stimulating application in rheumatism.

ACHILLEA MILLEFOLIUM Linn.

VERN.—Bomb.—*Rojmari*; Cutch.—*Biranjaisif*; Kash.—*Momadru chopandiga*; Afg.—*Bui maderan*.

This herb abounds in the Himalayas from Kashmir to Kumaon. The powdered leaves and flower-heads are useful as carminative and tonic in 5-30 grains doses. A hot infusion of the leaves is a powerful emmenagogue.

ACHYRANTHES ASPERA Linn.

VERN.—Sans.—*Apamarga*; Hind.—*Latjira*; Beng.—*Apang*; Bomb. & Mar.—*Aghada*; Punj.—*Kutri*, *Puthkanda*; Tam.—*Na-yurivi*; Tel.—*Apa margamu*; Mal.—*Katalati*; Guz.—*Aghedo*; Arab.—*Atkumah*; Pers.—*Khare-vashun*; Burm.—*Kune-la-mon*.

It is a small herb very common throughout India. The flowering spikes or the seeds of the plant, grounded and made into a paste with water have been used as an external application for bites of poisonous snakes and reptiles. Decoction of the whole plant is a good diuretic and is given in renal dropsy and general anasarca. For preparation of the decoction, about 2 ounces of the plant in one and a half pint of water should be boiled for 20 minutes to half an hour and then strained. One to two ounces of the mixture is given two or three times daily. The astringent property of the drug has also been noticed by some. A decoction of the powdered leaves with honey or sugar candy, is useful in the early stages of diarrhoea and dysentery.

ACONITUM (see page 52).

ACORUS CALAMUS Linn. (see page 262).

ADHATODA VASICA Nees (see page 264).

ADIANTUM CAPILLUS-VENERIS Linn.

VERN.—Hind.—*Hansraj*, *Mubaraka*; Kash.—*Duntuli*; Kumaon—*Mubaraka*; Arab.—*Shair-ul-jin*; Pers.—*Sir sia-peshane*; Guz.—*Hanspadi*.

It is known as Maiden-hair fern. It is chiefly obtained in the Punjab bazars and can also be had in some parts of Southern India. The expressed juice with pepper is a favourite remedy in all kinds of fever. A syrup prepared from the leaves is useful in chronic cough.

AEGLE MARMELOS Corr. (see page 267).

ALANGIUM LAMARCKII Thw.; see *A. salviifolium* (Linn. f.) Wang.

ALANGIUM SALVIIFOLIUM (Linn. f.) Wang. (syn. *A. lamarckii* Thw.) (see page 270).

ALLIUM CEPA Linn.

VERN.—Sans.—*Palandu*; Hind. & Pers.—*Piyaz*; Beng.—*Piyaj*; Bomb.—*Piyaj*, *Kanda*; Tam.—*Irulli*; Tel.—*Nirulli*; Guz. & Sind.—*Dungari*; Assam—*Piyas*; Kan.—*Nirulli*; Mal.—*Barwang*; Sing.—*Lunu*; Burm.—*Kesun-ni*; Arab.—*Basl*.

Onion is widely cultivated throughout India and is largely consumed as a food. Two varieties—Bombay and Patna—are obtainable in Bengal, the latter being of superior kind. Externally, onion has been used to allay the irritation due to the bites of scorpion and other insects and mixed with mustard oil it is useful in rheumatic and other joint troubles and in skin diseases. Internally, it has been used as a stimulant, expectorant and aphrodisiac.

ALLIUM SATIVUM Linn. (see page 271).

ALOCASIA INDICA Schott

VERN.—Sans.—*Manaka*; Hind.—*Mankanda*; Beng.—*Mankachu*; Mar.—*Alu*.

The underground stem of this plant is a common domestic remedy in gout and rheumatism. Dr. Kanai Lal Dey gives a formula for a preparation, which is called '*manmanda*.' Powdered *A. indica* 3 ounces, powdered rice 6 ounces, water and milk 20 ounces, boiled and given in doses of 1-2 ounces in cases of gout, rheumatism and dropsy.

ALOE (see page 61).

ALSTONIA SCHOLARIS R. Br. (see page 276).

ALUM.

VERN.—Sans.—*Sphatikari*; Hind.—*Phitkari*; Beng.—*Phatkiri*; Tam.—*Pati-karam*; Tel.—*Pati-karam*; Mar.—*Phatki*; Mal.—*Patikkaram*; Burm.—*Keo-khin*; Arab.—*Zaj*; Pers.—*Zake-safed*.

It is procurable in the bazar in colourless, transparent crystalline masses. Alum is a valuable astringent gargle in sore throat, ulceration of the mouth and gums in a strength of 2 drachm to a pint of decoction of gall or *Babul* bark or of plain water. The following combination is useful as a local application for gangrenous ulcers. Finely powdered alum 4 drachms, finely powdered catechu 1 drachm, opium $\frac{1}{2}$ drachm, kokum butter or ghee 1 ounce. Alum lotion has also been highly valued in traumatic swellings of joints and in bites of insects. 3-6 grains of alum in one ounce of distilled water is used as an eye lotion in chronic conjunctivitis. Internally, it is administered to check haemorrhage from lungs, stomach, kidney and other organs or to arrest excessive menstrual flow. A preparation known as 'lime whey', is a popular remedy and is prepared by boiling for ten minutes, 2 drachms of powdered alum in a pint of milk and then straining. As a haemostatic, its use is recommended in bleeding from the nose and other mucous surfaces. In chronic diarrhoea, the following mixture will be found useful: alum 10 grains, laudanum 5 drops, infusion of acorus root 1½ ounces.

AMMONII CHLORIDUM.

VERN.—Sans.—*Navasara*; Hind.—*Nousadar*; Beng.—*Nishadul*; Mar.—*Navsagar*; Tam.—*Nava-charum*; Tel.—*Nava-charum*; Guz.—*Navasagar*; Mal.—*Nava-saram*; Arab.—*Milhun-nar*; Pers.—*Noshadar*; Sing.—*Navacharam*; Burm.—*Zarasa*.

The bazar 'sal ammoniac' is generally impure. Most of the stuff that comes to the bazar in India is manufactured from a kind of clay found at Karnal in the Punjab. As a local application, it is useful in threatening mammary abscess, sprains, rheumatism, lumbago, sciatica, and headache. In hysteria, nervousness, jaundice and other liver complaints and gastric catarrh, doses of 10-20 grains three times daily are beneficial. It is often prescribed as a stimulating expectorant in chronic bronchitis and in pneumonia in the stage of resolution.

AMOMUM SUBULATUM Roxb.

VERN.—Sans.—*Brihat-upakunchika*; Hind.—*Bari-ilachi*; Beng.—*Bara-elachi*; Tam.—*Periya-yelakkay*; Tel.—*Pedda-yela-kayalu*; Kan.—*Dodda-yalakki*; Mar.—*Mote-veldode*; Mal.—*Periya-elattari*; Guz.—*Moto-ilachi*; Burm.—*Pala*; Arab.—*Qakilahac-kibar*; Pers.—*Qakilahc-kalan*.

It is a native of Nepal. Owing to its cheapness, it is frequently employed in place of *Elettaria cardamomum*—the true cardamom. The seeds are stomachic, carminative and stimulant.

ANACYCLUS PYRETHRUM DC.

VERN.—Sans.—*Akara karava*; Hind., Beng. & Bomb.—*Akarkara*; Tam. & Tel.—*Akkirakaram*; Mar.—*Akkalkadha*; Kan.—*Akkala-kare*; Guz.—*Akorkaro*; Arab.—*Aquarqarha*.

The root of the plant is regarded as a tonic to the nervous system and has been given in paralysis, hemiplegia, epilepsy, chorea and a host of other diseases. From its property as a sialagogue, it has been frequently administered to backward children in the Deccan to make them talk. Such a belief is unfounded. A decoction of the root will be found useful as a gargle in carious teeth, sore throat and tonsillitis.

ANANAS COMOSUS Merr. (syn. *A. sativus* Schult. f.).

VERN.—Hind.—*Anannas*; Beng.—*Anaras*; Mar. & Guz.—*Ananas*; Tam.—*Anashap-pazham*; Tel.—*Anasa-pandu*; Kan.—*Ananasu-hannu*; Mal.—*Annanas*; Arab. & Pers.—*Aainunnas*; Sing.—*Annasi*; Burm.—*Nanna-ti*.

The pineapple is a very common fruit in the bazar. It is not truly indigenous but has been introduced from Brazil. The juice of the fresh leaves mixed with sugar is regarded as anthelmintic and purgative. The fruit itself is largely consumed and is believed to possess antiscorbutic properties.

ANANAS SATIVUS Schult. f.; see *A. comosus* Merr.

ANDROGRAPHIS PANICULATA Nees (see page 278).

ANDROPOGON CITRATUS DC.; see *Cymbopogon citratus* (DC.) Stapf.

ANETHUM SOWA Kurz (see page 216).

ANTHEMIS NOBILIS Linn.

VERN.—Hind.—*Babuni-ke-phul*; Tam.—*Shimai-chamantipu*; Tel.—*Sima-chamanti-push-pam*; Mal.—*Shima-jevanti-pushpam*; Kan.—*Shime-shyamantige*; Arab.—*Babunaj*; Pers.—*Babunah*.

This plant is a native of Europe but is to some extent cultivated in the Punjab. The flowers in the form of infusion is carminative. It has been found useful in hysteria and dysmenorrhoea. A warm infusion can be used as anthelmintic for children.

ARECA CATECHU Linn. (see page 280).

ARGEMONE MEXICANA Linn. (see page 283).

ARISTOLOCHIA BRACTEATA Retz.

VERN.—Sans.—*Dhumrapatra*, *Patrabunga*; Hind.—*Kiramar*; Bomb.—*Kidamari*; Tam.—*Adutina-palai*; Tel.—*Kadapara*; Mal.—*Atutintappala*; Uriya.—*Paniri*.

It grows along the banks of the Ganges and is also met with in Southern India. Every part of the plant has been used in medicine and is extremely bitter. An infusion prepared from about $\frac{1}{2}$ an ounce of the dried plant in 10 ounces of water is regarded as anthelmintic and emmenagogue; dose 1 to 2 ounces. Powdered dry root in doses of 1-2 drachms is said to increase the contractions of uterus during labour and is used in Sind as a substitute for ergot.

ARISTOLOCHIA INDICA Linn.

VERN.—Sans.—*Rudrajata*; Hind.—*Isharmul*; Beng.—*Isarmul*; Bomb. & Mar.—*Sapasan*; Cutch & Guz.—*Ruhimula*; Goa.—*Sapus*; Tam.—*Ich-chura-muli*; Tel.—*Ishvara-veru*; Mal.—*Ishvara muri*; Kan.—*Ishveri-veru*; Santal.—*Bhedi janetet*; Arab. & Pers.—*Zaravande-hindi*.

It grows nearly all over India. The root and the stem are generally available from the drug dealers. The taste is bitter with a slight smell like camphor. Decoction of the root and the stem in doses of 1-2 ounces is stimulant, tonic and febrifuge. With black pepper and ginger, it is used as a carminative in diarrhoea and various forms of bowel complaints. Fresh juice of the leaves is a favourite antidote to bites of poisonous snakes. The root has been used for criminal abortion.

ASPARAGUS ADSCENDENS Roxb.

VERN.—Hind.—*Sufed-musli*; Bomb.—*Sapheta musali*; Guz.—*Saphed-musli*; Mar.—*Safeda musali*; U.P.—*Khairuwa*; Arab. & Pers.—*Shaqaqule-hindi*.

It is found in Bombay, Rohilkhand, Oudh and some other parts of India. The dried tuberous roots obtained in the bazar are known as 'safed musli'. The colour of the tubers is white and they swell up with water. They have got excellent cooling and demulcent properties and are frequently administered with boiled milk and sugar in diarrhoea and dysentery.

ASPARAGUS SARMENTOSUS Linn.

VERN.—Sans.—*Satavari*; Hind.—*Shakakul*, *Satavari*; Beng.—*Satamuli*; Bomb.—*Shatavari*; Tam.—*Kilavari*; Tel.—*Challa gaddalu*; Guz.—*Shatavari*; Sind.—*Tilora*; Mar.—*Satava-ri-mul*; Mal.—*Shata-vali*; Assam.—*Hatmul*; Sing.—*Hatavari*; Burm.—*Kanyo-mi*.

This species is found generally in Northern India and is sometimes substituted for *A. adscendens* as 'safed musli'. The root, on account of its high mucilagenous content is used as a demulcent and as a tonic in all devitalizing conditions. Boiled with some bland oil, the root has been used in various skin diseases.

ASTERACANTHA LONGIFOLIA Nees (syn. *Ilygrophila spinosa* T. And.).

VERN.—Sans.—*Ikshugandha*, *Kokilaksha*; Hind.—*Talmakhana*, *Gokhula kanta*, *Gokshura*; Beng.—*Kuliakhara*, *Kantakalika*; Bomb.—*Talimkhana*, *Kolsunda*; Mar.—*Talimakhana*; Tam.—*Nirmalli*; Tel.—*Nirguvi veru*; Santal.—*Gokhula janun*.

This spiny bush is common throughout India. The whole plant has been used medicinally, specially the root and the leaves. A decoction of the root is useful in hepatic derangement and genito-urinary disease as a diuretic. About 2 ounces of the root is boiled in a pint of water for 20 minutes to half an hour in a closed vessel. Dose of the preparation should be 1 to 2 ounces two or three times daily. All parts of the plant have similar medicinal properties and can be bought almost in every important bazar of India.

ATROPA ACUMINATA Royle ex Lindl. (see page 72).

AZADIRACHTA INDICA Juss. (syn. *Melia azadirachta* Linn.) (see page 360).BACOPA MONNIERI (Linn.) Pennell (syn. *Herpestis monniera* H. B. & K.) (see page 341).

BALIOSPERMUM MONTANUM Muell.-Arg.

VERN.—Sans., Hind. & Beng.—*Danti*; Bomb.—*Dantimul*; Tel.—*Adavi-amudan*; U. P.—*Jangli jamalgota*; Arab.—*Habbussala*; Pers.—*Bedanjire-khatai*; Lepcha.—*Poguntig*.

It is one of the commonest drugs of North and East Bengal reaching as far as Burma. The root is sold as 'dantimul' by the drug dealers. The seeds have properties more or less similar to *Croton tiglium* and are employed as a drastic purgative. Locally the seeds act as stimulant and rubifacient. The root and the leaves have similar properties and are used in the indigenous medicine in dropsy and general anasarca.

BALSAMODENDRON MUKUL Hook. (see page 285); also known as *Commiphora mukul* (Hook. ex Stocks) Engl.BALSAMODENDRON MYRRHA Nees; see *Commiphora myrrha* (Nees) Engl.BAMBUSA ARUNDINACEA Retz.; see *B. bambos* DruceBAMBUSA BAMBOS Druce (syn. *B. arundinacea* Retz.).

VERN.—Sans.—*Vansa*; Hind. & Beng.—*Bans*; Bomb.—*Mandgay*; Punj.—*Magar*; Tam.—*Mangal*; Tel.—*Bonga*; Guz.—*Wans*; Konkan.—*Kalak*; Santal.—*Mat*; Assam.—*Bnah*; Sing.—*Una*; Burm.—*K'yakatwa*; Arab.—*Qasab*; Pers.—*Nai*.

Bamboo is one of the commonest plants in India. Apart from its commercial importance in paper industry and in building huts and cottages, it has found some place in the indigenous medicine owing to the presence of a substance known as 'Bansolochana' in Sanskrit or as 'Tabashir' in Persian. 'Bansolochana' is a siliceous deposit in the interior of the stem of *B. bambos*. Two varieties are available in the market, the blue and the white, both having a sweet taste. It is much prized as a stimulant and febrifuge. In paralytic complaints, asthma, cough and other debilitating diseases, the drug is greatly valued in the indigenous medicine. The young leaves, in the form of a decoction combined with some aromatic substance, have also been used as an emmenagogue.

BASSIA LATIFOLIA Roxb. and B. LONGIFOLIA Linn.; see *Madhuca latifolia* (Roxb.) Macbride and *M. longifolia* (Linn.) Macbride.

BERBERIS (see page 288).

BLUMEA LACERA DC.

BÆRHAAVIA DIFFUSA Linn. (see page 297).

BORASSUS FLABELLIFER Linn. (syn. *B. flabelliformis* Roxb.).

VERN.—Sans.—*Tala*; Hind.—*Taltar*, *Tal*; Beng.—*Tal*; Tam.—*Panna-maram*; Tel.—*Tati-chettu*; Guz.—*Tad*; Mar.—*Talat-mad*; Mal.—*Pana*; Santal.—*Tale*; Sing.—*Tal*; Burm.—*Tan*; Pers.—*Darakhtetari*.

It is a tall palm growing in the sandy localities along the river banks. The juice of the plant is taken as a stimulant beverage and has some laxative property. By the fermentation of this juice, an intoxicating liquor (toddy) is prepared which is a favourite drink among the labouring classes. Toddy poultice, prepared in combination with flour of rice is a stimulating application to inflamed parts. The expressed juice from the young terminal buds and the decoction of the root have been used in gastritis and hiccough.

BORASSUS FLABELLIFORMIS Roxb.; see *B. flabellifer* Linn.

BRASSICA JUNCEA (Linn.) Czern. & Coss.

VERN.—Sans.—*Rajika*; Hind.—*Rai*, *Sarson*; Beng.—*Rai sarisha*; Bomb.—*Rai*; Mar.—*Rayan*; Kash.—*Asur*; Sing.—*Abba*.

Brassica juncea is the common Indian mustard and is largely employed medicinally along with black mustard, *Brassica nigra*. Mustard poultice prepared with cold water forms an excellent counter-irritant in many inflammatory and neuralgic affections, in abdominal colic and obstinate vomiting. In no case the plaster should be in contact with the skin for more than ten minutes. One or two teaspoonfuls of mustard in water, is an efficient emetic to empty the stomach in cases of poisoning. A hot mustard bath is an emmenagogue.

BUTEA FRONDOSA Koen. ex Roxb.; see *B. monosperma* (Lam.) Kuntze

BUTEA MONOSPERMA (Lam.) Kuntze (syn. *B. frondosa* Koen. ex Roxb.) (see page 301).

CÆSALPINIA BONDUCELLA Flem.; see *C. crista* Linn.

CÆSALPINIA CRISTA Linn. (syn. *C. bonducella* Flem.) (see page 304).

CALCI HYDROXIDE.

VERN.—Sans.—*Churna*; Hind.—*Chuna*; Beng.—*Chun*; Punj.—*Kalai*; Guz.—*Chuno*; Tam.—*Chunambu*; Tel.—*Sunna*; Arab.—*Kils*, *Ahu*; Pers.—*Nurah*; Burm.—*Thon-phiyu*.

CALCI OXIDE.

VERN.—Hind.—*Kalika-chuna*; Tam.—*Kar-shunnambu*; Tel.—*Ralla sunnamu*; Punj.—*Chunah*.

Calcium is a well-known remedy in all inflammatory swellings. It is popularly used in the form of lime water. Lime water is prepared by adding two ounces of slaked lime to a gallon of water and decanting off the supernatant clear fluid after the whole mixture has been allowed to stand for a time. In combination with some bland oil lime water forms a good emollient in burns and scalds, skin diseases, sore nipple etc. About 3 ounces of lime water as an enema is found quite effective in threadworms in children. Given internally it forms a good antacid in dyspepsia and heart burn. In obstinate vomiting and diarrhoea, vomiting of children, in consumption, in poisoning by mineral acids, lime water is a handy

and really useful remedy. An elegant way of prescribing lime water is to give it in combination with milk, 4 or 5 ounces being added to a pint of milk.

CALOPHYLLUM INOPHYLLUM Linn.

VERN.—Sans.—*Punnaga*; Hind.—*Sultana champa*, *Surpunka*; Beng.—*Punnag*; Bomb.—*Undi*; Mar.—*Surangi*, *Nagchampa*; Tam.—*Punnagam*; Tel.—*Punagamu*, *Ponna-chettu*; Cutch.—*Udi*; Sing.—*Domba*; Mal.—*Betan*; Burm.—*Pongnyet*.

The leaves of this tree are employed in eye diseases. The bark is astringent and a decoction of it is used as a wash for indolent ulcers. The kernel of the seeds yields a dark yellow oil which is used commonly as lamp-oil and medicinally as a stimulant application in rheumatism.

CALOTROPIS GIGANTEA (Linn.) Dryand. and *C. PROCERA* (Linn.) Dryand. (see page 305).

CALYOPTERIS FLORIBUNDA Lam.

VERN.—M.P.—*Kohoranj*; Mar.—*Ukshi*; Tel.—*Bandimurudu-du*; Mysore.—*Marsada boli*.

It is a large shrub growing in Central India, the Deccan and Assam. The juice from the young twigs is used in diarrhoea and dysentery. Dr. Koman of Madras advocated its use as an anthelmintic and laxative.

CAMELLIA SINENSIS (Linn.) O. Kuntze (syn. *C. theifera* Griff.) (see page 79).

CAMELLIA THEIFERA Griff.; see *C. sinensis* (Linn.) O. Kuntze

CANNABIS SATIVA Linn. (syn. *C. indica* Lam.) (see page 84).

CAPSICUM ANNUUM Linn. and other species.

VERN.—Hind. & Punj.—*Mattisa*, *Mirch*; Beng.—*Lanka-marich*, *Gach-marich*; Kumaon.—*Mattisa-wangru*; Kash.—*Mirch-wangum*; Guz.—*Marchu*; Mar.—*Mairsinga*; Tam.—*Milagay*; Tel.—*Mirapa-singa*; Mala.—*Kappal-melaka*; Sans.—*Marichi-phalam*; Arab.—*Ahmur*; Pers.—*Filfile-surkh*; Sing.—*Miris*; Burm.—*Na yop*.

Chillies are used daily as condiment and are grown abundantly throughout India. The three important varieties of capsicum, *C. annum*, *C. fastigiatum* and *C. minimum* differ in size, shape and colour. When applied locally they produce blisters and the fresh fruits made into a paste in combination with mustard are used as counter-irritant. They have been used as a gargle in sore throat and hoarseness and internally, in dyspepsia and loss of appetite, as useful adjunct to aloes. A pill made of capsicum, ginger and rhubarb is carminative and may be advantageously employed in atonic dyspepsia.

CARDIOSPERMUM HALICACABUM Linn.

VERN.—Sans.—*Karavi*; Beng.—*Lataphatkari*; Punj.—*Habul-kalkal* (seed); Guz.—*Karotio*; Bomb.—*Bodha*; Tam.—*Muda-cottan*; Tel.—*Budha-kakara*; Burm.—*Ma-la-mai*; Arab.—*Laftaf*; Sing.—*Painaira-wel*.

This plant is plentiful in every part of India. A decoction of the root in doses of 4 to 6 ounces is considered as a diuretic, diaphoretic and laxative. Dr. U. C. Dutt recommends the following preparation as an emmenagogue. Equal parts of leaves of *C. halicacabum*, potassium carbonate, root of *Acorus calamus* and root bark of *Terminalia tomentosa* are rubbed into a paste with milk. One drachm of the preparation daily is said to effect a free menstrual flow in about three days. The whole plant has also been used both internally and externally in rheumatism and lumbago.

CARICA PAPAYA Linn. (see page 309).

CARUM CARVI Linn. (see page 92).

CARUM COPTICUM Benth. & Hook f.; see *Trachyspermum ammi* (Linn.) Sprague

CARYOPHYLLUS AROMATICUS Linn. (see *Eugenia caryophyllus*, page 172); also known as *Syzygium aromaticum* (Linn.) Merr. & Perry.

CASSIA ALATA Linn.

VERN.—Sans.—*Dadrughna*; Beng.—*Dadmari*; Hind.—*Dadmurdan*; Mar.—*Dadamardana*; Tam.—*Shimai-agati*; Tel.—*Sima avist*; Kan.—*Shime-agase*; Sing.—*Attora*; Burm.—*Maizali-gi*.

This is a common handsome shrub with yellow flowers. The bruised leaves, applied locally in the form of an ointment, have a great reputation in skin diseases and are regarded as a specific for ringworm.

CASSIA ANGUSTIFOLIA Vahl (see page 98).

CASSIA AURICULATA Linn.

VERN.—Hind.—*Tarwar*; Mar.—*Taravada*; Guz.—*Awal*; Tam.—*Avari*; Tel.—*Tangedu*; Cutch.—*Awala*; Kan.—*Taravadagida*; Mal.—*Avara*; Sing.—*Rana-vara*.

It is called the tanner's cassia, as the bark is one of the most valuable of Indian tans. Finely powdered, decorticated seeds have been used as a dusting powder in conjunctivitis. The bark is considered astringent; it has been much used as a gargle in sore throat in place of oak gall and seems to be 'worthy of trial'. A decoction of the whole plant or the flower buds has been tried in diabetes.

CASSIA LANCEOLATA Linn.; see *C. angustifolia* Vahl, page 98.

CENTELLA ASIATICA (Linn.) Urban (syn. *Hydrocotyle asiatica* Linn.).

VERN.—Sans.—*Mandukaparni*, *Cheka-parni*; Hind.—*Brahmamanduki*, *Khulakhudi*; Beng.—*Thol-kuri*, *Brahmamanduki*; Bomb.—*Karivana*, *Karinga*; Tam.—*Valla-rai*, *Babassa*; Tel.—*Manduka-bramha-kuraku*; Arab.—*Artaniyal-hindi*.

C. asiatica is a weed common in all parts of India. For a long time it has been used by the Indian physicians as a remedy for various skin diseases. The leaves are only recognised in the Pharmacopoeia Indica, but many investigators have advocated the use of the entire plant, root, twigs, leaves and seeds in medicine, especially the first named which contains the major portion of the active volatile principle 'vellarin'. The leaves are dried in the shade so that no active principle is lost, powdered and kept in well stoppered bottle. This powder is used as a remedy for eczema, leprosy, secondary syphilitic ulcers either as an ointment with vaseline or as a dusting powder. Internally, it has been used as an alterative and tonic and can be administered in the powdered form in 5-10 grain doses three times daily. A decoction of the entire plant one ounce in a pint, boiled for about 15 minutes, is an elegant preparation in doses of 1 to 2 ounces.

CENTRATHERUM ANTHELMINTICUM (Willd.) Kuntze (syn. *Vernonia anthelmintica* Willd.) (see page 434).

CEPHALANDRA INDICA Naud.; see *Coccinia indica* W. & A.

CERA ALBA and C. FLAVA (Wax).

VERN.—Sans.—*Madhujan*; Hind., Beng., Dec. & Pers.—*Mom*; Kash.—*Sinth*; Guz.—*Min*; Mar. & Kan.—*Mena*; Tam.—*Mellugu*; Tel.—*Mai-nam*; Sing.—*Itti*; Arab.—*Shama*; Burm.—*Phayouii*.

Wax has got very little medicinal property. Its chief use is as a plaster and as a basis for ointments. The following preparation is considered to be an effective application to boils. Equal quantities of *Balsamodendron mukul*, *B. pubescens*, wax and sesame oil are melted together and is applied over the affected part in the form of a plaster.

CERBERA THEVETIA Linn. and THEVETIA NERIIFOLIA Juss.; see *T. peruviana* (Pers.) Merr.

CHENOPODIUM (see page 100).

CHENOPODIUM ALBUM Linn.

VERN.—Sans.—*Vastuk*; Hind. & Beng.—*Bathu-sag*, *Chandan betu*; Punj.—*Bathua*; Tam.—*Parupu kire*; Tel.—*Pappu kura*; Bomb.—*Chakwit*; Sind.—*Jhil*; Arab.—*Kulf*.

It is widely grown throughout India, in the plains and also in the hilly tracts of Kashmir and Sikkim. The leaves of the plant are taken in the form of infusion or decoction, as a laxative and anthelmintic. The seeds are consumed by the hill tribes as an article of food. It has been recommended by the Hindu physicians in hepatic disorders and in splenic enlargement.

CICHORIUM INTYBUS Linn.

VERN.—Hind. & Pers.—*Kasni*; Tam.—*Kashini-virai*; Tel.—*Kasini-vittulu*; Punj.—*Gul*; Arab.—*Hindyba*; Guz.—*Kasani*.

In the Punjab plains and in Kashmir, chicory is cultivated as a fodder, and the roots and seeds are very common drugs of the Punjab bazars. The root is dried, powdered and mixed with coffee as an adulterant. It has also been described as a useful medicine in congestion of the liver and resembles taraxacum in its pharmacological properties. The powdered seeds can be employed in disorders of menstruation.

CINNAMOMUM CAMPHORA (Linn.) Nees & Eberm. (see page 120).

CINNAMOMUM ZEYLANICUM Breyn. (see page 126).

CISSAMPELOS PAREIRA Linn. (see page 320).

CISSUS QUADRANGULARIS Linn. (syn. *Vitis quadrangularis* Wall.).

VERN.—Sans.—*Vajra-valli*, *Asthisanhara*; Hind.—*Har-jora*, *Nallar*, *Harsankar*; Beng.—*Hasjora*, *Harjora*, *Harbhanga*; Bomb.—*Harsankar*, *Harjora*, *Nallar*, *Kandavla*, *Chodhari*; Tam.—*Perunde codie*; Tel.—*Nalleru*, *Nulle rutigeh*.

The leaves and stem are frequently taken with curry in Southern India. In Madras, the young shoots of the plant are burnt to ashes in a closed vessel and administered in dyspepsia and indigestion. The juice of the stem is said to be useful in otorrhoea and epistaxis.

CITRULLUS COLOCYNTHIS (Linn.) Schrad. (see page 128).

CITRUS AURANTIUM Linn.

VERN.—Sans.—*Nagaranga*; Hind.—*Narangi*, *Kumla nembu*; Beng.—*Kamla nebu*; Punj.—*Santara*; Bomb.—*Naringi*; Tam.—*Kitchli*; Tel.—*Ganjanimma*; Arab.—*Naranj*; Pers.—*Narang*; Burm.—*Thau-ba-ya*.

The orange is cultivated principally in the Khasia Hills in Assam and in the Central Provinces which are the two sources of supply to the Indian market. The fruit is largely consumed and is a valuable antiscorbutic. The rind of orange, in the form of infusion or tincture, is a valuable stomachic, and carminative in dyspepsia, flatulance and gastric irritabilities in general. Powdered orange peel, magnesium carbonate and rhubarb form a useful carminative preparation.

CITRUS MEDICA Linn. (see page 130).

CLEOME ICOSANDRA Linn. (syn. *C. viscosa* Linn.).

VERN.—Sans.—*Aditya bhakta*; Beng.—*Hur-huria*; Hind.—*Hurhur*; Punj.—*Hul hul*; Bomb.—*Kanphuti*; Tam.—*Nahi-kuddaghu*; Tel.—*Kukha-avalu*.

It grows commonly throughout India. The juice of the leaves mixed with warm ghee is used in earache and inflammation of the middle ear. The seeds resemble mustard seeds in action and a poultice made with lime water, vinegar and warm water is efficacious in chronic painful joints as a counter irritant. The powdered seeds are employed in doses of $\frac{1}{2}$ to 1 drachm twice daily as an anthelmintic.

CLEOME VISCOSA Linn.; see *C. icosandra* Linn.

CLERODENDRUM INFORTUNATUM Linn.

VERN.—Sans.—*Bhandira*; Beng.—*Ghetu*; Punj.—*Kali basuti*; Bomb.—*Kari*; Mar.—*Bhandira*; Tel.—*Bockada*; Kan.—*Nayi bela*; Nepal—*Chitu*.

C. infortunatum is a common shrub with pinkish flowers growing throughout the waste land areas in India and also in Ceylon. The juice of the leaves has for a long time been used as an antiperiodic in malaria in doses of 1-2 ounces. Though definite antimalarial properties have not been demonstrated, it is a good bitter tonic after attacks of ague. Decoction of the leaves has been used as an anthelmintic in roundworm infection.

COCCINIA INDICA W. & A. (syn. *Cephalandra indica* Naud.) (see page 314).

COFFEA ARABICA Linn. (see page 79).

COLCHICUM LUTEUM Baker (see page 131).

COMBRETUM PILOSUM Roxb.

VERN.—Hind.—*Bhoree loth*, *Thoonia loth*.

It is a shrub growing in the Cachar district, Assam. Decoction of the leaves is useful as anthelmintic.

COMMIPHORA MYRRHA (Nees) Engl. (syn. *Balsamodendron myrrha* Nees).

VERN.—Sans.—*Rasagandha*; Hind.—*Bol*; Beng.—*Gandharash*; Tam.—*Vellaiṭ-polam*; Tel.—*Balimtra-polam*; Guz. & Cutch.—*Hirabol*; Kan.—*Bola*; Sing.—*Bolam*; Arab.—*Murr*; Pers.—*Bol*.

Myrrh of commerce is obtained from the resinous exudation of the tree *C. myrrha*. Quite a large quantity of myrrh is imported into Bombay from East Africa, Arabia, Persia and Siam. There are at least two or three varieties, two of them being known as 'Karam' and 'Mutiya'. The bazar variety is heavily adulterated and substituted by other allied species. Myrrh is a good astringent mouth wash in stomatitis and sore throat. It is a stimulating expectorant and can be advantageously administered in chronic bronchitis and phthisis. Tincture of myrrh is useful in menstrual disorders and chlorosis of young girls.

CONVOLVULUS SCAMMONIA Linn.

VERN.—Hind., Sind., Arab. & Pers.—*Sak munia*; Punj.—*Sakmunia*.

Scammony resin is obtained from the rhizomes of *C. scammonia*. Most of the bazar stuff is imported into India from Syria and Asia minor and the Bombay drug dealers adulterate it with other inert substances. Scammony is a hydragogue cathartic and is largely administered in dropsy and anasarca.

COPTIS TEETA Wall. (see page 292).

CORIANDRUM SATIVUM Linn.

VERN.—Sans.—*Dhanyaka*; Hind.—*Dhanya*; Beng.—*Dhane*; Bomb.—*Dhana*; Tam.—*Kotamalli*; Tel.—*Kotimiri*; Arab.—*Kuzbarah*; Pers.—*Kushniz*; Burm.—*Nau-nau*.

The seeds are used as a condiment in every household. An infusion of the seeds is useful in flatulence, indigestion, vomiting and other intestinal disorders. In combination with cardamom and caraway it forms a good carminative mixture.

CRATÆVA NURVALA Buch.-Ham. and other species.

VERN.—Sans.—*Varuna*; Hind.—*Barna*; Beng.—*Barun*; Punj.—*Barna*; Bomb. & Mar.—*Kumla*; Tam.—*Maralingam*; Tel.—*Uskia*; Burm.—*Katat*; Kan. & Mal.—*Nirvala*, *Vitusi*.

Two varieties of cratæva are important from medicinal point of view, *C. nurvala* and *C. roxburghii*. A decoction prepared from 4 ounces of the bark of the former in 1½ pint of water is said to be a good antiperiodic and tonic in doses of about 2 ounces two or three times daily. This mixture is also said to be useful in cases of kidney and bladder stones. The leaves of *C. roxburghii* are very good counter-irritant and can be used as a substitute for mustard. For this purpose, a poultice made of the fresh leaves with lime water or warm water is employed.

CROTON TIGLIUM Linn.

VERN.—Sans.—*Jayapala*; Beng.—*Jaypal*; Hind.—*Jamal-gota*; Tam.—*Ncrvalum*; Tel.—*Nepala-vitua*; Kan.—*Nepala*; Mar.—*Jepul*; Guz.—*Nepal*; Burm.—*Kanako*; Malay.—*Bori*; Java.—*Cheraken*; Pers.—*Dund*; Arab.—*Batu*, *Dand*.

The croton seeds are oval shaped with a light coloured shell and a soft kernel inside. They are used as a drastic and violent purgative in conditions like apoplexy, insanity and convulsions attended with high blood pressure. The doses in such cases should never exceed 2 grains mixed with honey. The expressed oil from the seed is given in doses of 1 minim only. The oil has been tried as counter irritant and vesicant in rheumatism, synovitis, paralysis and painful affections of joints and limbs.

CUMINUM CYMINUM Linn. (see page 93).

CUPRUM SULPHAS

VERN.—Sans.—*Tuttha*; Hind.—*Nila-tuta*; Beng.—*Tutia*; Tam.—*Mayil-tuttam*; Tel.—*Mayilu-tuttam*; Malay.—*Turi*; Guz.—*Mortuta*; Arab.—*Zajul-akhzar*; Pers.—*Zake-sabz*; Burm.—*Doutha*.

Copper sulphate occurs in blue crystalline masses. The stuff obtained from the bazar is usually impure. It may be purified by dissolving in water and re-crystallising. For internal administration, a special method of purification is recommended by the Hindu physicians. Bazar copper sulphate is rubbed with honey or ghee and then exposed to heat for some time. It is then soaked in water for three days and finally dried in the sun. In doses of ½ to 2 grains it is said to be beneficial in chronic diarrhoea and dysentery. Large doses will act as emetic and are frequently used in opium, nux vomica and arsenic poisonings. In indolent ulcers and exuberant granulations, a weak lotion will be found effective. In epistaxis and other forms of bleeding from mucous surfaces, a lotion made by adding 4 grains of copper sulphate to an ounce of water is recommended.

CURCULIGO ORCHIOIDES Gaertn.

VERN.—Sans.—*Mushali*; Hind. & Bomb.—*Kali-musli*; Beng.—*Tala muli*; Tam.—*Nilap-panaik-kishangu*; Tel.—*Nela tadi*; M.P.—*Mussulkund*; Sing.—*Ilin-bin-tal*.

C. orchioides is the 'kala musli' of the bazar and has to be distinguished from the tuberous root of *Asparagus adscendens* which goes by the name of 'safed musli'. The root contains a good deal of mucilage and is used as a demulcent alterative and tonic during convalescence after acute illness. A palatable form of administration is to give about 1 to 2 ounces of the root in warm milk and sugar.

CURCUMA AROMATICA Salisb.

VERN.—Sans.—*Vanaharidra*; Hind.—*Jangli-haldi*; Beng.—*Banhalud*; Bomb.—*Ambe-haldi*; Tam.—*Kasturi-manjal*; Tel.—*Kasturi pasupa*; Guz.—*Kapur kachali*; Kan.—*Kasturi-arishima*; Burm.—*Kiyasa noim*; Sing.—*Duda-kaha*; Arab.—*Judwar*.

Uses similar to *Curcuma longa*.

CURCUMA LONGA Linn. (see page 325).

CYMBOPOGON CITRATUS (DC.) Stapf. (syn. *Andropogon citratus* DC.).

VERN.—Sans.—*Bhustrina*; Hind.—*Aginghas*, *Gandha trina*; Beng.—*Gandha bena*; Mar.—*Olancha*; Guz.—*Lilicha*; Tam.—*Vashanup-pulla*; Tel.—*Chippa-gaddi*; Kan.—*Pur-hali-hulla*; Pers.—*Chae-kashmiri*; Sing.—*Penquin*.

The lemon grass grows throughout India. The oil distilled from the leaves of *C. citratus* is the commonly known 'lemon grass oil' which is used medicinally. The oil obtained from *Vetiveria zizanioides* (*Andropogon muricatus*), *C. nardus* and *C. schoenanthus* is a valuable product of perfumery and is not used in medicine. Lemon grass oil is sherry coloured with a pungent taste and lemon-like odour. Three to six drops of the oil either with sugar or in emulsion act as carminative in flatulence, colic and obstinate vomiting. A decoction made from the leaves is recommended as a diaphoretic in fever. Locally applied in rheumatism, lumbago and sprains, it is a good embrocation and affords relief.

CYPERUS ROTUNDUS Linn.

VERN.—Sans.—*Musta*; Beng.—*Mutha*; Bomb.—*Musta*; Guz.—*Motha*; Tam.—*Korai*; Tel.—*Gandala*; Mar.—*Bimbal*; Sing.—*Kalanduru*.

The rounded rhizome of the plant is found everywhere in India. The bulbous root is largely used by Kavirajes, grounded with ginger and honey and given as astringent, stomachic and carminative in gastric and intestinal disorders. The Romans used it as emmenagogue in uterine complaints.

DÆMIA EXTENSA R. Br.; see *Pergularia extensa* N. E. Br.

DATURA (see page 134).

DIPTEROCARPUS LÆVIS Ham., D. ALATUS Roxb. and other species.

VERN.—Hind. & Bomb.—*Garjan-ka-tel*; Tam.—*Yennai*.

Several species of Dipterocarpus plants grow in Chittagong, Burma and Siam. These plants yield an oleoresinous extract which is popularly known as 'guarjan balsam' or 'wood oil'. The 'gurjan oil', procurable in the Indian bazars, is chiefly the product of *D. lævis* and *D. alatus*. The oil has a pale grey or light brown colour and may be as thick as honey. It resembles copaiba balsam and has been used as a substitute for oil of copaiba in the treatment of gonorrhoea in doses of $\frac{1}{2}$ to 1 teaspoonful in mucilage, milk or gruel, twice or thrice daily. At one time, the balsam was used both internally and externally in the treatment of leprosy but it has since been discontinued.

ECLIPTA ALBA Hassk.

VERN.—Sans.—*Kesaraja*; Hind.—*Mochkand*, *Bhangra*, *Babri*; Beng.—*Kesuti*, *Keysuria*, *Keshuri*; Bomb.—*Maka*, *Bhangra*, *Dodhak*; Tam.—*Karisha-langanni*, *Kaikesi*; Tel.—*Galagara*, *Guntakalagar*.

The roots and the leaves of the plant are considered to be cholagogues and have been largely used alone or in combination with ajowan seeds in derangements of the liver and gallbladder. They have also been used as substitutes for taraxacum, a reputed and popular liver tonic.

ELETTARIA CARDAMOMUM Maton (see page 142).

EMBELIA RIBES Burm. f. and E. TSJERIAM-COTTAM A. DC. (syn. *E. robusta* Roxb.).

VERN.—Sans.—*Vidanga*; Hind.—*Baberang*, *Wawrung*; Beng.—*Bhiranga*, *Bhai-birung*; Punj.—*Babrung*; Bomb.—*Karkannie*, *Vaivarang*, *Vavadinga*; Tam.—*Vayu-vilamgam*, *Vellal*; Tel.—*Vayu-vilamgam*; Pushtu—*Babrang*.

The seeds of these plants are used as an anthelmintic. Powdered seeds in doses of one

to two drachms are administered with sugar or honey in an empty stomach to expel tapeworms.

EMBLICA OFFICINALIS Gaertn. (syn. *Phyllanthus emblica* Linn.).

VERN.—Sans.—*Amalaki*, *Dhatri*; Hind.—*Amla*, *Aura*; Beng.—*Amla*, *Amlaki*; Uriya.—*Amlaki*; Santal.—*Meral*; Assam.—*Amluki*; Nepal.—*Amla*; U.P.—*Amla*, *Asula*; Punj.—*Ambal*, *Amla*; Bomb.—*Avalkati*, *Amla*; Guz.—*Amla*; Tam.—*Nelli-kai*; Tel.—*Usri*, *Nelli*; Burm.—*Shabju*; Arab.—*Amlaj*; Pers.—*Amuleh*.

The embelic myrobalan, the fruit of *E. officinalis* is a common medicine used everyday in Indian households. The fruit has got a sour, astringent taste and is diuretic and laxative. A decoction prepared from the fruit combined with *Terminalia chebula* and *T. belerica* is useful in chronic dysentery and biliousness, in doses of one ounce once or twice daily.

ENICOSTEMMA LITTORALE Blume

VERN.—Hind.—*Chota-kirayata*; Bomb.—*Manucha*, *Kadavinayi*; Tam.—*Vallari*; Tel.—*Nela-guli*, *Nela-gulimidi*.

It is known as 'chota chiretta' in some parts of India. The flowering plants are used as stomachic, carminative and bitter tonic and are commonly available in the Punjab and Bombay bazars.

EUGENIA JAMROLANA Lam.; see *Syzygium cumini* (Linn.) Skeels

EUPHORBIA HIRTA Linn. (syn. *E. pilulifera* Linn.) (see page 335).

EUPHORBIA NERIIFOLIA Linn.

VERN.—Sans.—*Snuhi*, *Vujri*; Hind.—*Sehund*, *Thohar*, *Sij*, *Patton-ki-send*; Beng.—*Mansa-sij*, *Pata-sij*, *Hij-daona*; Bomb.—*Minguta*, *Mingut*, *Nivadunga*, *Thohur*, *Thor*, *Newarang*; Tam.—*Ilaik-kalli*; Tel.—*Aku-jemudu*; Burm.—*Shasaung*, *Shazavn-mina*.

This plant is found in the hilly regions of Central India and is also cultivated in Bengal. The fleshy cylindrical stems exude when injured, a milky juice which is used to relieve earache. In combination with chebulic myrobalans and long peppers, the juice is also given as a drastic purgative in dropsy and general anasarca.

EUPHORBIA PILULIFERA Linn.; see *E. hirta* Linn.

FERRI SULPHAS.

VERN.—Sans.—*Kasisa*; Hind.—*Kasis*, *Hira kasis*, *Kahi*; Beng.—*Hirakos*, *Hira-kosis*; Bomb.—*Kashish*, *Hira-kashish*; Tam. & Tel.—*Anna-bedi*.

Crude, greenish blue crystals of sulphate of iron are available in all the bazars in India. On account of its astringent properties, it is used as a lotion in crysipelas, in anaemia and constitutional debility following on malaria, kala-azar, etc., the following prescription has been found useful: ferri sulphas 4 grains, omum water 6 ounces, infusion chiretta 6 ounces. Two ounces of the mixture is given twice or thrice daily.

FERULA FETIDA Regel (see page 174).

FICUS BENGALENSIS Linn.

VERN.—Sans.—*Vata*; Hind.—*Bor*, *Bar*, *Bargat*; Beng.—*Bat*, *Bar*; Punj.—*Bera*, *Bor*, *Bohar*, *Bargad*; Bomb.—*Wad*, *Barghat*, *Bur*, *Vada*; Tam.—*Ala*; Tel.—*Mari*, *Peddi mari*; Pushtu.—*Baagat*, *Bar*.

The banyan tree is planted throughout India. It grows to a height of about 100 feet and is a common roadside tree. The milky juice that exudes from the tree is a valuable astringent in sores and ulcers. Infusion of the young buds, owing to the large percentage of tannin it contains, is useful in diarrhoea and dysentery. An infusion of the bark is said to have specific properties of reducing the blood sugar in diabetes.

FICUS GLOMERATA Roxb.; see *F. racemosa* Linn.

FICUS RACEMOSA Linn. (syn. *F. glomerata* Roxb.).

VERN.—Sans.—*Udumbara*; Hind.—*Gular, Paroa, Lelka, Umar, Tue, Dimeri*; Beng.—*Jagya-dumar, Yajnadumbar*; Punj.—*Kathgular, Krumbal, Rumbal, Batbor, Palak, Kakammal, Dadhuri*; Bomb.—*Umbar, Umbar gular, Atti, Rumadi*; Tam.—*Atti*; Tel.—*Moydi, Atti, Bodda, Paidi, Mari, Medi*.

It is a large tree found in Bengal, Central India, Assam, Burma, and the Deccan. The bark, leaves, fruits and the milky exudation have all been employed in indigenous medicine. An infusion of the bark and the leaves is astringent and has been employed as mouth wash in spongy gum and also internally in dysentery, menorrhagia and haemoptysis. The fruit is considered to be astringent and carminative. Both the fruit and the sap extracted from the trunk of the tree have been described as valuable medicine in diabetes.

FICUS RELIGIOSA Linn.

VERN.—Sans.—*Aswaththamu, Asvattha*; Hind.—*Pipal*; Beng.—*Ashathwa, Aswat, Asud*; Punj.—*Pipal, Bhor*; Bomb.—*Pimpal, Piplo, Pipur, Pipul*; Tam.—*Arasa, Aswartham*; Tel.—*Rai, Raiga, Ravi, Kulla ravi*.

The 'peepul' tree grows wild in many parts of India and is also cultivated, as it is held sacred by the Hindus. An infusion of the bark is astringent and has been used in unhealthy ulcers and various skin diseases.

FISH LIVER OIL.

VERN.—Hind.—*Mach-chi-ka-tel*; Beng.—*Macher tel*; Bomb.—*Masolicha-tela*; Tam.—*Min-yenney*; Tel.—*Chepa-nune*.

Extraction of oil from the fish is carried on in many places along the west coast of India. Fish oil is used as a cheap substitute for cod liver oil. Oil derived from the livers of fishes like hilsa, sharks, skates, sand fishes, etc., is beneficial in debilitating diseases and in malnutrition. One to two teaspoonfuls of fish oil, sweetened and flavoured, can be given once or twice daily in phthisis and rickets. Most of the fish oil available in the market, however, is not distilled from the livers only but is crudely manufactured from the whole fish. Such oil therefore has very little utility as a therapeutic agent and moreover turns rancid quickly on keeping.

FÆNICULUM VULGARE Mill. (see page 176).

FUMARIA OFFICINALIS Linn. and *F. PARVIFLORA* Lam.

VERN.—Hind.—*Pitpapara, Pitpapra*; Beng.—*Ban-sulpha*; Bomb.—*Pitpapra, Shatra, Pitpapda*; Tam.—*Tura*; Tel.—*Chata-rashi*; Arab.—*Bukslat-ul-mulik, Baglatul-mulk*; Pers.—*Shatra, Shahtarah*; Pushtu—*Shahtara, Pitpapra, Papra*.

F. officinalis is not indigenous to India but is imported into the country from Persia. An allied variety, *F. parviflora*, is found throughout the Indo-gangetic plain. An infusion prepared from the stem and the leaves is used in dosage of 1 to 2 ounces thrice daily as alterative, tonic, diuretic and diaphoretic.

GARCINIA INDICA Choisy. (syn. *G. purpurea* Roxb.).

VERN.—Hind.—*Kokam, Kokam-ka-tel*; Bomb.—*Kokam, Amsul* (the fruit), *Kokam chatel, Ratambu-sala, Bhirand, Katambi, Bhirandel*; Tam.—*Murgalmara*.

The oil expressed from seeds is known as 'Kokum' butter. Owing to its emollient and soothing properties, it is considered an excellent substitute for animal fat as a basis for ointment.

GARCINIA MANGOSTANA Linn.

VERN.—Hind.—*Mangustan*; Beng.—*Mangustan*; Bomb.—*Mangostin, Mangustan, Manga-stin*; Burm.—*Mengkop, Mambu, Mengut, Youngsaloi*.

Mangosteen fruit is chiefly imported into India from Singapore and the Strait Settlements, though to some extent it is cultivated in Burma and Madras Presidency. The decoction of the rind of the fruit is a domestic remedy for diarrhoea and dysentery.

GARCINIA PURPUREA Roxb. (see *G. indica* Chois.).

GENTIANA KURROO Royle and other species (see page 181).

GHEE

VERN.—Sans.—*Ghrita*; Hind.—*Ghi*; Beng.—*Ghee*, *Ghrita*; Tam. & Tel.—*Neyi*.

Ghee is chiefly prepared from the milk of cows and buffalows. It is an esteemed article of diet and its local application over blisters and inflammatory swellings is much in vogue. Old ghee is very useful as a local application in pleurisy and painful affections of joints.

GLORIOSA SUPERBA Linn.

VERN.—Sans.—*Langalika*, *Agnisikha*, *Kalikari*; Hind.—*Kariari*, *Karihari*, *Languli*; Beng.—*Bishalanguli*, *Ulatchandal*, *Bisha*; Punj.—*Mulim*, *Kariari*; Bomb.—*Karianag*, *Nagkaria*, *Indai*; Tam.—*Kalaippaik-kishangu*, *Karttikaik-kishangu*; Tel.—*Agni-shikha*, *Kalappa-gadda*, *Adavi nabhi*, *Potti dumpa*.

It is common in the forests of Bengal, Burma and Ceylon. The tubers are flattened or cylindrical in shape and very bitter to the taste. Its use as an abortifacient has been mentioned by the old sanskrit writers. Contrary to the popular belief, the root is not poisonous in ordinary doses. On the other hand, it seems to possess alterative and tonic properties. A paste formed with water is a useful anodyne application in bites of poisonous insects and reptiles.

GLYCYRRHIZA GLABRA Linn. (see page 183).

GMELENA ARBOREA Linn.

VERN.—Sans.—*Gumbhari*, *Sripnari*; Hind.—*Kumbhar*, *Gumbhar*, *Kambhar*; Beng.—*Gamari*, *Gumar*, *Gumbar*; Bomb.—*Shewun*; Punj.—*Kumhar*, *Gumhar*; Tam.—*Gumudu tekku*, *Gumadi*; Tel.—*Gumar-tek*, *Pedda gomru*; Santh.—*Kasmar*; Burm.—*Yamanai*.

The root, fruit, bark and leaves of this plant have all been used in medicine, but the root and the fruit are to be preferred. An extract of the root is bitter and tonic and has been administered in various ailments. Combined with liquorice, honey and sugar, it is considered to be galactagogue.

GYMNEMA SYLVESTRE R. Br. (see page 336).

GYNOCARDIA ODORATA R. Br. (see page 416).

HEDYCHIUM SPICATUM Ham. *ex* Smith.

VERN.—Sans.—*Kapurakachali*; Hind.—*Sit-ruti*, *Kapur kachri*; Bomb.—*Sir*, *Sutti*; Mar.—*Kapur krachari*; Punj.—*Khor*, *Kachur-kachu*, *Ban kela*, *Sheduri*, (Bazar root)= *Kapur kachri*; Tam.—*Shimai-kich-chilik kishangu*.

The plant grows abundantly in the Punjab and Nepal. The root-stock that is found in the bazar is reddish brown in colour with a pungent bitter taste. It is the common ingredient of 'abir' that is used in India during the 'holi' festival. Medicinally the root stock is employed as a stomachic, carminative and bitter tonic.

HEDYOTIS AURICULARIA Linn.; see *Oldenlandia auricularia* K. Schum.

HELICTERES ISORA Linn. (see page 340).

HEMIDESMUS INDICUS R. Br. (see page 187).

HERPESTIS MONNIERA H. B. & K.; see *Bacopa monnieri* (Linn.) Pennell

MADHUCA LATIFOLIA (Roxb.) Macbride and M. LONGIFOLIA (Linn.) Macbride (syn. *Bassia latifolia* Roxb. and *B. longifolia* Linn. respectively) (see page 356).

MALLOTUS PHILIPPINENSIS Muell.-Arg. (see page 358).

MEL

VERN.—Sans. & Beng.—*Madhu*; Hind. & Bomb.—*Madha*; Tam.—*Taen*; Tel.—*Taenu*; Punj.—*Saht*; Kash.—*Mhach*; Malay—*Ayurmader*; Sing.—*Mipanny*; Burm.—*Pya-ya*.

Although it has no marked medicinal properties, honey is extensively used in every household of India. The honey that is sold in the bazar is derived from the honeycomb of several species of wild bees. Chemically, honey is mainly a mixture of dextrose and levulose. It is a pleasant vehicle for administering bitter mixtures for cough and fever especially in children.

MELALEUCA LEUCADENDRON Linn.

VERN.—Hind.—*Kayaputi*; Beng.—*Cajuputte*; Bomb.—*Kayakuti*; Mar.—*Cajuputa*; Tam.—*Kayapute*, *Kijapute*; Malay.—*Cajuputi*, *Kaya putia*.

The plant is a native of Tenneserim, Malay islands and Australia. The leaves yield on distillation, a thin, greenish essential oil known as Cajuput oil. A large quantity of the oil is imported into Singapore from Java, Manilla and Celebes and other places and thence to Calcutta and Bombay. Cajuput oil is a favourite remedy in inflamed and painful joints. The oil when taken internally is said to be useful in cholera and diarrhoea but is apt to produce inflammation of the kidney.

MELIA AZADIRACHTA Linn.; see *Azadirachta indica* Juss.

MENTHA ARVENSIS Linn. (see page 196).

MIMUSOPS ELENGI Linn.

VERN.—Sans.—*Bakula*; Hind. & Beng.—*Bakul*; Bomb.—*Borsali*; Punj.—*Maulsari*; Tam.—*Magilam*; Tel.—*Vakulam*; Malay—*Elengi*; U.P.—*Maulsari*; Uriya—*Baulo*; M.P.—*Gholsari*; Guz.—*Bolsari*; Burm.—*Khaya*; Sing.—*Munemal*.

This tree is largely cultivated in the Deccan and other parts of India. The astringent property of the bark has long been recognised and a decoction prepared from it is used as gargle. The seeds are purgative and are sometimes effective as a suppository in children. A fatty oil distilled from the seeds is available in Tanjore.

MORINGA OLEIFERA Lam. (syn. *M. pterygosperma* Gaertn.) (see page 364).

MORINGA PTERYGOSPERMA Gaertn.; see *M. oleifera* Lam.

MUSA PARADISIACA Linn. var. *SAPIENTUM* Kuntze

VERN.—Sans.—*Kadali*, *Rambha*; Hind., Bomb., Punj. & Guz.—*Kela*; Beng.—*Kala*; Tam.—*Vazhaip pazham*; Tel.—*Ariti*, *Kadali*; Sind.—*Kewiro*; Malay—*Vasha*; Sing.—*Kadali*, *Rambha*; Burm.—*Yathi-lan*; Pers. & Arab.—*Mous*.

The banana tree is common throughout India. The green tender leaves form an excellent cover for denuded surfaces and are extensively used in indigenous surgical practice. The ripe fruit is emollient and demulcent and is rich in vitamin content.

MUSA SAPIENTUM Linn.; see *M. paradisiaca* Linn. var. *sapientum* Kuntze

MYLABRIS CICHORII Linn. (see page 472).

MYRICA NAGI Thunb.

VERN.—Sans.—*Katphala*; Hind., Beng., Bomb. & Sind.—*Kaiphāl*, *Kayaphul*; Punj.—*Kaphal*, *Kaiphāl*; Tam.—*Marudampattai*; Tel.—*Kaidaryamu*; Malay—*Marutamtoli*; Nepal—*Kobusi*; Guz.—*Kariphāl*; Arab.—*Asuri*; Pers.—*Darshishaan*.

The plant is found chiefly in West Pakistan and in Simla district. The decoction of the bark mixed with ginger and cinnamon is a favourite remedy in chronic bronchitis, asthma and catarrhal conditions of the lungs. It is also given in diarrhoea and dysentery as an astringent.

MYRISTICA FRAGRANS Houtt. (see page 200).

MYRISTICA OFFICINALIS Linn.; see *M. fragrans* Houtt. page 200.

MYRSINE AFRICANA Linn.

VERN.—Hind.—*Chapra*; U.P.—*Chupra*; Punj.—*Bebrang*; Arab.—*Baibarang*.

This green shrub is found in the Himalayas from Kashmir to Nepal. The fruits are used medicinally for their anthelmintic and cathartic properties.

NARDOSTACHYS JATAMANSI DC.

VERN.—Sans., Hind. & Beng.—*Jatamansi*; Bomb.—*Balacharea*; Tam.—*Jatamashi*; Tel.—*Jatamamshi*; Guz.—*Jatamasi*; Kan.—*Jetamavashi*; Malay.—*Jctamanshi*; Sing.—*Jara mansi*; Arab.—*Sumbulul-hind*; Pers.—*Sunbuluttib*.

The roots met with in the bazar are really the under-ground stems, having the thickness of a goose quill. They possess an aromatic odour and a somewhat bitter taste and should always be used fresh. The infusion prepared from the roots has a great reputation in spasmodic attacks of hysteria, palpitation of heart and chorea in doses of 1-2 ounces three times daily. The powdered root is given in doses of 10-20 grains.

NAREGAMIA ALATA W. & A.

VERN.—Bomb.—*Pittpapra*; Kan.—*Nepa-naringu*; Malay.—*Nela-naregan*; Goa.—*Trifolio*.

This is known as 'Goanese Ipecacuanha' and is found in Western and Southern India. Decoction of the stem and leaves has been used in dysentery with successful result and is said to be as effective as ipecacuanha. The root has a pungent aromatic odour and is emetic and expectorant; it is useful in chronic bronchitis and helps to expel mucus.

NELUMBium SPECIOSUM Willd.; see *Nelumbo nucifera* Gaertn.

NELUMBO NUCIFERA Gaertn. (syn. *Nelumbium speciosum* Willd.).

VERN.—Sans. & Bomb.—*Kamala*; Hind.—*Kanwal*; Beng.—*Padma*; Tam.—*Ambal*; Tel.—*Erra-tamara-veru*; Uriya.—*Padam*; Punj.—*Kanwal*; Sind.—*Pabban*; Malay.—*Tamara*; Arab. & Pers.—*Nilufer*.

The lotus is an aquatic herb found everywhere in India. The root, flowers, stalk and leaves in the form of infusion are used in fever as refrigerant and diuretic.

NICOTIANA TABACUM Linn.

VERN.—Hind.—*Tamaku*; Beng.—*Tamak*; Bomb.—*Tambakhu*; Tam.—*Pugai-yilay*; Tel.—*Pogaku*; Kan.—*Hoge sappu*; Malay.—*Puka yila*; Burm.—*Sacpin*; Sing.—*Dunga zha*; Arab.—*Tanbak*; Pers.—*Tanbaku*.

Tobacco plant is cultivated in Bengal, Burma, Madras and other parts of India. *N. rustica*, the Turkish tobacco is also cultivated in some parts of Northern India. Tobacco leaves can be bought in every bazar of India and are used in various ways, e.g. they are smoked, chewed with pan, or are mixed with molasses to form 'tamak'. Owing to the presence of nicotine and nicotianine, excessive tobacco smoking gives rise to chronic inflammation of the bronchial mucous membrane, nervous depression and sleeplessness. Decoction of the leaves is a useful external application in inflammatory swellings and tobacco leaves have been used in orchitis. For spongy gums and toothache, chewing of tobacco leaf is a favourite remedy in India.

NIGELLA SATIVA Linn.

VERN.—Sans.—*Krishna-jiraka*; Hind. & Beng.—*Kala jira*; Bomb.—*Kalenjire*; Tam.—*Karun-shirogam*; Tel.—*Nalla-jilakra*; Kan.—*Kari-jirigi*; Kash.—*Tukm-i-gandna*; Afg.—*Siyah-daru*; Burm.—*Samon-ne*; Sing.—*Kaluduru*; Arab.—*Sh-ouniz*; Pers.—*Siyah-danah*.

The seeds possess well-marked carminative and stomachic properties and are used in combination with other aromatic substances and bitters. A favourite external application used in eczema and pityriasis is composed of bruised seeds 2 ounces, *Psoralea corylifolia* seeds 2 ounces, bdellium 2 ounces, cuscini radix 2 ounces, sulphur 1 ounce and cocoanut oil 2 pints.

OCIMUM BASILICUM Linn.

VERN.—Sans.—*Munjariki*; Hind.—*Sabzah*, *Babui-tulsi*; Beng.—*Babui tulsi*; Punj.—*Baburi*; Mar.—*Sabza*; Tam.—*Tirnut-patchi*; Tel.—*Bhu-tulasi*; Malay—*Tiru nitru*; Uriya—*Dhala tulasi*; Santal—*Bharbari*; Sind.—*Sabajhi*; Arab.—*Shahasfaram*; Pers.—*Firanj-mushk*.

This herb is common throughout India. The seeds contain a large amount of mucilage and are demulcent and diuretic. A teaspoonful of the seeds in a glass of water with some sugar forms an excellent drink useful in gonorrhoea and cystitis.

OCIMUM SANCTUM Linn.

VERN.—Sans., Tam. & Tel.—*Tulashi*; Hind., Beng., Punj. & Bomb.—*Tulsi*; Guz.—*Talasi*; Kan.—*Tulashi-gida*; Malay—*Krishna-tulsi*; Mar.—*Tulasa*; Burm.—*Lun*; Sing.—*Muduru-tulla*.

The sacred 'tulsi' plant is met with in many Hindu houses. The leaves are expectorant in chronic cough especially in children and are given sweetened with honey.

OLDENLANDIA AURICULARIA K. Schum. (syn. *Hedyotis auricularia* Linn.) (see page 339).

OLDENLANDIA BIFLORA Linn.

VERN.—Sans. & Beng.—*Khetpapra*; Hind.—*Daman-papar*; Tel.—*Verri nela vemu*; Goa—*Kazuri*; Nepal—*Piriengo*; Sing.—*Wal-patpaadagam*.

It is a common plant of India. A decoction of the whole plant, the root, the stem and the leaf is used in liver complaints. In chronic malaria, the decoction is said to be a good febrifuge.

ONOSMA BRACTEATUM Wall.

VERN.—Hind., Beng. & Tam.—*Gaozaban*, *Shankhahuli*.

This is the 'gaozaban' that is obtained in most of the bazars of India. The leaves and flowers that are sold in the market are heavily adulterated with other varieties. Though much applauded by the indigenous practitioners as a tonic and an alterative, according to O'Shaughnessy the usefulness of the drug has been overrated. One ounce of 'gaozaban' in a pint of water, boiled for some time forms a useful diuretic and demulcent mixture and alleviates thirst and restlessness during fever.

OPERCULINA TURPETHUM (Linn.) Silva Manso (syn. *Ipomœa turpethum* R.Br.) (see page 194).

OPHELIA CHIRATA DC.; see *Swertia chirata* Buch.-Ham., page 250.

ORCHIS LATIFOLIA Linn., **O. MASCULA** Linn. and other species.

VERN.—Hind., Pers. & Afg.—*Salap*, *Salab*; Beng.—*Salep misri*; Bomb.—*Salum*.

The tuberous roots of these orchids and allied species are sold in the market under the name of 'salep misri'. These roots, finely powdered and boiled with milk, form a nutritious article of diet and are given in phthisis, diabetes, chronic diarrhoea and dysentery.

OROXYLUM INDICUM Vent.

VERN.—Sans.—*Syonaka*; Hind.—*Sauma*, *Arlu*; Beng.—*Sona*; Punj.—*Tatpalang*; Bomb.—

Sauna-assar, Tetu; Tam.—*Vanga, Pana*; Tel.—*Pampana*; Uriya.—*Pomponia*; Santal.—*Bana halak*; Assam.—*Kering*; Nepal.—*Totilla*; C. P.—*Tattunua*; Burm.—*Kyoung-sha*; Sing.—*Totilla*.

This tree is common throughout India. The root bark is a common medicine of the Hindu materia medica and forms one of the ingredients of 'dasamula,' (the compound decoction of ten roots) a favourite remedy in diarrhoea and dysentery. In otorrhoea, an oily preparation of the root bark with sesamum oil is recommended by Dr. U. C. Datta. The powdered bark in 5-15 grain doses or as an infusion, has been recommended in rheumatic affections.

OXALIS CORNICULATA Linn.

VERN.—Sans.—*Amlika, Chukrika*; Hind. & Beng.—*Amrul*; Bomb.—*Ambuti*; Tam.—*Paliakiri*; Tel.—*Pallachinta, Anboti-kura*; Punj.—*Chukha, Amrul*; Santal.—*Tandi chato-marak*; Assam.—*Chengeri tenga*; U.P.—*Ambuti*; Malay.—*Poliyarala*; Arab.—*Hemda*.

The leaves of the plant have been used in fever, dysentery and scurvy. In dysentery, the fresh juice of the leaves mixed with honey or sugar is said to be useful. In the Punjab and West Pakistan the juice of the whole plant along with onion is applied to remove warts.

PÆDERIA FÆTIDA Linn.

VERN.—Sans.—*Prasarani*; Hind.—*Gandhali, Somraj, Somaraji*; Beng.—*Gandhabhadulia*; Assam.—*Bedoli sutta*; Nepal.—*Padebiri*; Bomb.—*Prasaram*; Mar.—*Hiranvel*; Guz.—*Gandhana*; Tel.—*Savirela*.

It is a common climber found in the Himalayas and also in Bengal and Assam. A soup prepared from the leaves is considered a good remedy for diarrhoea and dysentery and in fact, is given as a household remedy during convalescence from acute illness. The entire plant has been used externally for application on rheumatic joints.

PAPAVER SOMNIFERUM Linn. (see page 202).

PAVONIA ODORATA Willd.

VERN.—Sans.—*Bala, Hriversa*; Beng. & Hind.—*Bala*; Bomb.—*Bala*; Mar.—*Kala-vala*; Tam.—*Paramutty, Peramutiver*; Tel.—*Errakuti*; Kan.—*Balarakkasi-gida*.

The root possesses an aromatic odour and mention is made of it in the Hindu medicine. Preparation of the root with 'bel' fruit (*Aegle marmelos*) is considered useful in dysentery.

PEDALIUM MUREX Linn.

VERN.—Hind.—*Farid-buti, Bara-gokhru*; Beng.—*Bara-ghokru*; Uriya.—*Gokshura*; Punj.—*Gokru kalan*; Mar.—*Mothe-gokharu*; Guz.—*Mothan gokharu*; Tam.—*Peru-nerunji*; Tel.—*Pedda-palleru*; Kan.—*Anne-galu-gida*; Malay.—*Kathunerinjal*; Burm.—*Sule-gi*; Sing.—*Ati-neranchi*; Arab.—*Khasake-kabir*; Pers.—*Khasake-kalan*.

The plant grows abundantly on the sea coast of Southern India and Ceylon. The yellow flowers when bruised emit a musk-like odour. The leaves when soaked in water will render the whole fluid mucilaginous and for this property, it has been advocated in gonorrhoea. An extract of the fresh leaves and stem in cold water is an efficient diuretic. About half a pint of the infusion taken daily is said to alleviate the burning sensation during micturition in gonorrhoea. It has also been tried in nocturnal emissions and impotency.

PEGANUM HARMALA Linn. (see page 368).

PERGULARIA EXTENSA N. E. Br. (syn. *Daemia extensa* R. Br.).

VERN.—Hind.—*Utran, Sagovani*; Beng.—*Chhagal-bati*; Tam.—*Veli-parutti*; Tel.—*Jitupaku*; Mar.—*Utarani*; Guz.—*Nagala-dudheli*.

This plant has been used extensively for its emetic and expectorant properties especially in the Bombay Presidency. Powdered leaves in doses of 5-10 grains or a decoction of the leaves in 1-2 ounce doses are good expectorants. The juice of *Ocimum sanctum* and honey are sometimes added to the decoction to help the expectorant effects.

PEUCEDANUM GRAVEOLENS Linn. (see page 216).

PHYLLANTHUS EMBLICA Linn.; see *Emblica officinalis* Gaertn.

PICRASMA QUASSIOIDES Benn. (see page 217).

PICRORHIZA KURROA Royle *ex* Benth. (see page 181).

PIMPINELLA ANISUM Linn. (see page 219).

PINUS LONGIFOLIA Roxb.; see *P. roxburghii* Sargent

PINUS ROXBURGHII Sargent (syn. *P. longifolia* Roxb.) and other species (see page 221).

PIPER BETLE Linn. (see page 371).

PIPER CUBEBA Linn. *f.* (see page 224).

PIPER LONGUM Linn.

VERN.—Sans.—*Pippali*; Hind.—*Pipal*; Santal.—*Ralli*; Beng.—*Pipul*; Nepal.—*Fiplu mol*; Punj.—*Pipal*, *Darfilfil*; Bomb.—*Pipli*; Mar.—*Pimpli*; Guz.—*Pipli*; Tam. & Tel.—*Pipili*; Kan.—*Yippali*; Malay.—*Lada*, *Mulagu*; Burm.—*Peikchin*; Sing.—*Tippili*; Arab.—*Dar-filfil*; Pers.—*Filfildray*, *Pipal*.

Long pepper is cultivated extensively in many places of Bengal, Assam and Madras. Bengal exports large quantities to Bombay and other parts in Northern India. Both the Hindu and Mohammedan physicians have used an infusion made from it as carminative, stimulant and alterative. It is a stimulant expectorant and can be administered in asthma and chronic bronchitis sweetened with sugar or honey. Pepper is largely consumed as an article of spice.

PIPER NIGRUM Linn.

VERN.—Sans.—*Maricha*, *Hapusha*; Hind.—*Gulmirch*; Beng.—*Gol-morich*; Kash.—*Martiz*; Punj.—*Gol-mirich*; Guz. & Bomb.—*Miri*, *Kala-miri*; Tam.—*Milagu*; Tel.—*Marichamu*; Kan.—*Mirialu*; Burm.—*Sa yo mai*; Afg.—*March*; Arab.—*Filfiluswud*; Pers.—*Pilpil*.

Black pepper forms one of the important articles of trade. It is cultivated along the western coast of India and that growing in the Malabar Coast is considered to be the best. Black pepper is stimulant and carminative and has been prescribed in cholera, dyspepsia, flatulence, diarrhoea and various gastric ailments. The following combination is used in the treatment of cholera: black pepper 20 gr., asafoetida 20 gr., opium 20 gr., made into 12 pills; one pill to be given every hour or every 2 hours. Locally, black pepper with ghee is believed to be a useful application for boils, urticaria and other skin diseases.

PISTACIA INTEGERRIMA Stew *ex* Brandis (see page 377).

PLANTAGO OVATA Forsk. (see page 379).

PLUMBAGO INDICA Linn. (syn. *P. rosea* Linn.) (see page 385).

PLUMBAGO ROSEA Linn.; see *P. indica* Linn.

PODOPHYLLUM EMODI Wall.; see *P. hexandrum* Royle

PODOPHYLLUM HEXANDRUM Royle (syn. *P. emodi* Wall.) (see page 226).

PONGAMIA GLABRA Vent.; see *P. pinnata* (Linn.) Merr.

PONGAMIA PINNATA (Linn.) Merr. (syn. *P. glabra* Vent.) (see page 388).

POTASSII NITRAS.

VERN.—Sans.—*Yava-kshra*; Hind. & Guz.—*Shora*; Beng.—*Sora*; Mar.—*Shora-mitha*; Tam.—*Potti-luppu*; Tel.—*Petluppu*; Malay.—*Veti-uppa*; Burm.—*Yan-zin*; Sing.—*Pot-lunu*; Arab.—*Ubkir*; Pers.—*Shora*.

The nitre obtained in the bazars is generally impure. For medicinal use, it is dissolved in water, strained and recrystallised. Potassium nitrate is a good diuretic and is useful in fevers, influenza, measles, smallpox, etc. Inhalation of burning nitre gives great relief in asthma and spasmodic cough.

PREMNA INTEGRIFOLIA Linn.

VERN.—Sans.—*Ganikarika*; Hind.—*Arni*, *Agetha*; Beng.—*Ganiari*; Uriya.—*Aguyabat*; Nepal.—*Gineri*; Garhwal.—*Bakorcha*; Bomb.—*Arni*; Mar.—*Chamari*; Tam.—*Munnay*; Tel.—*Ghebu-nelli*; Malay.—*Appel*; Burm.—*Toung-than-gyee*; Sing.—*Karnika*.

It is a common shrub met with in many parts of India especially along the sea coast. The root and the leaves have been mentioned by the old physicians as therapeutically active. A decoction of the root (about 4 ounces in a pint of water and boiled for 15 minutes) is given in doses of 2 to 4 ounces twice daily as a stomachic and a bitter tonic. The leaves have also been used for the same purpose.

PSIDIUM GUAJAVA Linn.

VERN.—Sans.—*Amruta-phalam*; Hind.—*Amrut*; Beng.—*Peyara*; Assam.—*Madhu riam*; Nepal.—*Amuk*; Punj.—*Amrut*; Bomb.—*Perala*; Mar.—*Jamba*; Tam.—*Segapu*, *Koaya*; Tel.—*Jama*; Kan.—*Sebe*; Burm.—*Malakatibeng*; Arab.—*Amrud*; Pers.—*Amrud*.

Guava tree is found throughout India and the fruit is largely eaten. The root, the stem bark and the leaves contain a large percentage of tannic acid. Decoction of the leaves make a cheap and efficacious gargle for swollen gums and ulceration of the mouth. The root bark is an excellent astringent; 2 ounces of the bark in a pint of water boiled down to $\frac{1}{2}$ pint makes an efficient mixture in infantile diarrhoea in doses of 1 to 2 teaspoonfuls two or three times daily.

PSORALEA CORYLIFOLIA Linn. (see page 391).

PUNICA GRANATUM Linn.

VERN.—Sans.—*Dadima*; Hind.—*Anar*; Beng.—*Dalim*; Punj.—*Daru*, *Jaman*; Bomb.—*Anara*, *Dalimba*; Tam.—*Madalam*; Tel.—*Dalimba*; Burm.—*Sale-bin*; Arab.—*Shajratur rumman*; Pers.—*Darakhte nar*.

The pomegranate is a much prized fruit and its medicinal virtues have been known for a long time. The rind of the fruit, the root bark and the juice of the fresh fruit have been used medicinally. It has been hailed as almost a specific for tapeworm infection. A convenient form of giving it without irritating the stomach is as follows: fresh bark 2 oz., water 2 pints, boiled down to 1 pint and strained. Two ounces of the mixture is taken in an empty stomach in the morning repeated every half hour till 4 doses are given. The bowel should be later emptied by a dose of castor oil. The remedy is said to expel the head of the worms. The astringent property of the bark and rind of the fruit has been made use of in the treatment of chronic diarrhoea and dysentery.

QUERCUS INFECTORIA Oliv.

VERN.—Sans.—*Majuphal*; Hind.—*Majuphal*, *Mazu*; Beng.—*Majuphal*; Bomb.—*Maiphal*; Tam.—*Machakai*; Malay.—*Majakani*; Burm.—*Pyintagar-ne-thi*; Arab.—*Uffes*; Pers.—*Mazu*.

The commercial galls used in medicine and dyeing are derived from this plant. It is not indigenous to India but grows in Greece, Asia Minor, Syria and Persia and is imported into

India. In medicine the galls are largely used as astringent and styptic. For external application an ointment with vaseline is used; combined with opium they are useful in anal fissures and ulcerating haemorrhoids. They have also been used in diarrhoea and dysentery and as gargle in stomatitis.

RHEUM EMODI Wall. and other species. (see page 233).

RICINUS COMMUNIS Linn. (see page 236).

ROSA DAMASCENA Mill. (see page 238).

SALIX CAPREA Linn.

VERN.—Hind. & Punj.—*Bedmushk*; Pushtu—*Khawagawala*; Arab.—*Khilaf*; Pers.—*Bedmishk*.

It is grown in the Punjab and Kashmir. All parts of the plant are available in the bazars of North-Western India. Decoction of the leaves is considered to be a febrifuge and the bark and stem have been used as astringent application in piles. An oil distilled from the leaves is used for making perfumed waters and as a tonic and aphrodisiac.

SALVIA ÆGYPTIACA Linn.

VERN.—Punj.—*Tukhm malanga*.

The plant grows in the plains of Punjab and is used as a cure for eye diseases. The seeds are used in diarrhoea, gonorrhoea and haemorrhoids.

SALVIA PLEBEIA R. Br.

VERN.—Beng.—*Bhui-tulsi*; Punj.—*Sathi*; Sind.—*Kinro*; Bomb.—*Kammar-kas* (seeds).

The plant grows all over India. The seeds are used in diarrhoea, gonorrhoea, menorrhagia and haemorrhoids.

SALVIA SPINOSA Linn.

VERN.—Punj.—*Kanocha*.

The triangular seeds of this plant are available in the Punjab bazars. When soaked in water, they form a thick mucilaginous drink much used in gonorrhoea and urethritis.

SANTALUM ALBUM Linn. (see page 241).

SARACA INDICA Linn. (see page 401).

SAUSSUREA LAPPA Clarke (see page 402).

SCILLA INDICA Baker (see page 251).

SCINDAPUS OFFICINALIS Schott

VERN.—Sans.—*Gaja-pippali*, *Kari-pippali*; Hind.—*Gajapipal*, *Maidah*, *Bari-pipli*; Beng.—*Gajapipal*, *Gaj-pipul*; Bomb.—*Thora-pimpli*; Tam.—*Attu-tippili*; Tel.—*Enuga-pippalu*, *Gaja-pippallu*; Santal—*Dare jhapak*.

It is a climbing plant growing throughout the plains of India. The sliced and dried fruit is obtainable in the bazar and is said to be carminative, tonic and anthelmintic.

SEMECARPUS ANACARDIUM Linn. f. (see page 407).

SESAMUM INDICUM DC.

VERN.—Sans.—*Tila*, *Snehaphala*, *Tila-taila* (oil), *Tilaha* (seed); Hind.—*Til*, *Tir*, *Krishna-tel*, *Mitha-tel*, *Til-ka-tel*; Beng.—*Til*, *Kala til*, *Sumsum*, *Chadu til*, *Rakta til*, *Sanki til*; Bomb.—*Til*, *Tal*, *Krishna-til*, *Barik-til*, *Ashadi-tal* (white), *Kala katwa* (black) *Purbia*

(red); Punj.—*Til, Tili, Kunjad*; Tam.—*Nal-lenny* (oil), *Yellu-cheddie, Ellu* (seed); Tel.—*Nuvvu, Nuvvulu, Manchinune* (oil), *Polla nuvvulu* (seed); Kumaon—*Bhunguru, Til*; Santal—*Tilmin*; Pers.—*Kunjad* (seed), *Roghune kunjad* (oil).

The oil expressed from the seeds is known in the bazar as 'til' oil. It is a good substitute for olive oil and can be used as an emollient in dressing wounds and ulcers. It was previously held to be a good application in cutaneous lesions of leprosy. On account of its high mucilage content, the leaves are given a high place in the treatment of chronic dysentery. The seeds have been used to produce abortion. A hot hip-bath with some bruised seeds in it is said to give relief in dysmenorrhoea.

SIDA CORDIFOLIA Linn. (see page 409).

SMILAX CHINA Linn.

VERN.—Sans.—*Chobachini*; Hind., Beng., Punj. & Bomb.—*Chobchini, Shuk-china*; Tam.—*Paringay*; Tel.—*Pirangi chekka, Gali chekka*; Sing.—*China-alla*.

The root is imported from China and is available in the bazar. Decoction of the root (2 ounces in a pint of water) after boiling for some time is said to be a good alterative and tonic in doses of 1 ounce thrice daily.

SODII BIBORAS

VERN.—Sans.—*Tan-kana*; Hind.—*Sohaga, Tinkal*; Beng.—*Sohaga, Suhaga*; Bomb.—*Kuddia-khar, Tankan-khar*; Punj.—*Sohaga, Tinkur, Tinkal*; Tam.—*Venkaram, Vengaram*; Tel.—*Velligaram, Elegaram*; Pers.—*Tinkar tankar*; Kash.—*Vavut*.

Borax is a common bazar drug and occurs in an impure condition. It can be purified by dissolving it in water, straining through cloth and evaporating to dryness. The local application of borax 1 drachm in an ounce of honey or other suitable vehicle, is useful in ulceration of mouth and cracks and fissures of tongue. In sore nipple, prickly heat and other forms of skin eruptions, it can be advantageously employed. A useful ointment is prepared by a combination of the following substances: borax 1 drachm, sulphur 1 drachm, catechu 1 drachm, ghee 1 ounce. Doses varying from 10-30 grains are given in prolonged labour, disorders of menstruation and other forms of uterine affections.

SOLANUM DULCAMARA Linn.

VERN.—Punj.—*Ruba barik* (=the leaves).

Dulcamara grows in the Western Himalayas from Kashmir to Gharwal, but a certain quantity is also imported into India from Persia. A decoction of the berries (1 to 2 ounces in a pint of water) is a suitable diuretic, diaphoretic and alterative mixture. Dose 1 to 2 ounces. It has also been given in syphilis, leprosy, chronic rheumatism and various skin diseases.

SOLANUM NIGRUM Linn.

VERN.—Sans.—*Kakamachi*; Hind.—*Makoi*; Beng.—*Gurkamai, Kakmachi, Tulidun*; Bomb.—*Kamuni, Ghati*; Punj.—*Kambe, Kachmach*; Tam.—*Munna-takali-pullun, Manattak-kali*; Tel.—*Kanchi-pundu, Kamanchi*; Arab.—*Anb-us-sa'lap*.

The black berries of this plant have been used as diuretic and diaphoretic for a long time in heart diseases when attended with swelling of the legs and feet. Freshly prepared extract from all portions of the plant, the berries, the leaves and the stem is also used in doses of 1-2 drachms. It is said to be effective in cirrhosis of liver.

SOLANUM TRILOBATUM Linn.

VERN.—Sans.—*Alarka*; Uriya—*Nabhi-ankuri*; Tam.—*Tudavullay*; Tel.—*Uchchinta, Uste*.

This is a common shrub of Southern India. A decoction of the root and leaves is given in consumption.

SOLANUM XANTHOCARPUM Schrad. & Wendl.

VERN.—Sans.—*Kantakari*, *Nidigdihika*; Hind.—*Kateli*, *Katai*; Beng.—*Kantakari*; Bomb.—*Bluringni*, *Ringni*; Punj.—*Warumba*, *Mahori*, *Mamoli*; Tam.—*Cundung katric*, *Kandan-kattiri*; Tel.—*Pinna mulaka*, *Vankuda*.

The root is one of the important medicinal ingredients of the Hindu physicians and has been recognised for a long time as an effective diuretic, expectorant and febrifuge. A decoction of this root with that of *Tinospora cordifolia* is said to be a tonic in fever and cough.

STRYCHNOS NUX-VOMICA Linn. (see page 248).

STRYCHNOS POTATORUM Linn. f.

VERN.—Sans.—*Kataka*, *Ambu-prasadu*; Hind.—*Nirmali*, *Nelmal*, *Neimal*; Beng.—*Nirmali*; Bomb.—*Nirmali*, *Gajrah*; Punj.—*Nirmali*; Tam.—*Tetan-kottai*, *Tettian*; Tel.—*Induga*, *Katakamu*, *Chettu*; Sing.—*Ingini*.

This tree is plentiful in Southern India. The seeds rubbed with a little honey and camphor are a favourite remedy with the indigenous practitioners in chemosis of the conjunctiva and profuse lacrymation. The seeds have been advocated by the Mohammedan physicians in chronic dysentery. Dr. Mohideen Sheriff in his *Materia Medica of Southern India* mentions the use of the pulp of the fruit in dysentery as a substitute for ipecacuanha.

SULPHUR

VERN.—Sans.—*Gandhaka*; Hind.—*Gundhak*; Beng.—*Gandhak*; Punj.—*Gandhak*, *Kibrit*, *Anwlasar*, *Gogird*; Tam.—*Gandakam*; Tel.—*Gandhakam*; Pers.—*Gangird*.

Sulphur is easily procurable in the bazars of India. The Hindu physicians describe four varieties of sulphur—the yellow, the white, the red and the black. The yellow variety is preferred for internal administration while the white variety is preferred for external application. In many households sulphur is used to disinfect rooms by fumigation. In scabies and many other parasitic diseases of the skin, powdered sulphur in $\frac{1}{2}$ chattack of bland oil is an efficient remedy. Internally, sulphur is a mild laxative and in combination with honey or milk is frequently prescribed in habitual constipation especially when complicated with piles.

SWERTA CHIRATA Buch.-Ham. (see page 250).

SYMPLOCOS RACEMOSA Roxb. (see page 413).

SYZYGIUM CUMINI (Linn.) Skeels (syn. *Eugenia jambolana* Lam.).

VERN.—Sans.—*Jambu*, *Jambula*; Hind.—*Jaman*, *Jam*, *Phalinda*, *Jamni phalani*, *Pharenda*, *Paiman*; Beng.—*Jam*, *Kala-jam*; Bomb.—*Jambul*, *Jambudo*, *Jambura*, *Jambudi*; Tam.—*Naval*, *Narvel*, *Nawar*, *Naga*; Tel.—*Naredu*, *Racha-neredu*, *Pedda-neredu*, *Nairuri*, *Nareyr*, *Nasodu*.

The seeds are considered astringent in diarrhoea and dysentery preferably in combination with the seeds of *Mangifera indica* (Mango). Powdered seeds are said to diminish the quantity of sugar in urine in diabetes. A decoction of the bark has also been used in cases of dysentery in combination with cardamom and cinnamon.

TAMARINDUS INDICA Linn.

VERN.—Sans.—*Amlika*, *Tintrini*, *Tintili*, *Ambia*; Hind.—*Amlī*, *Anbli*, *Imli*, *Amlīca*; Beng.—*Tentul*, *Ambli*, *Tintil*; Bomb.—*Amlī*, *Ambli*, *Chintz*; Punj.—*Imli*; Tam.—*Puli*, *Puliyam-pazham*; Tel.—*Chintapandu*, *Asek*; Sing.—*Siyembela*; Pers.—*Anbalah*; Uriya.—*Tentuli*.

The tamarind tree is common throughout India and has been valued as a medicine from remote times. The pulp of the fruit boiled with water and sweetened is a refrigerant, carminative and laxative and is much prescribed in febrile affections. The red outer covering of the seeds is considered to be a valuable remedy in diarrhoea and dysentery. For this about

10 grains of the powdered seeds with equal quantity of cumin seeds and sugar are given two or three times daily. In the absence of lemon, tamarind can be used for its antiscorbutic properties. The ripe pulp of the fruit is considered to be a very effective laxative in habitual constipation and enters into many of the medicines of the Hindu physicians. The leaves are astringent and can be used as a gargle or made into a poultice, are applied to inflammatory swellings.

TAMARIX GALLICA Linn.

VERN.—Sans.—*Jhavuka*, *Shavaka*; Hind. & Beng.—*Jhav jhau* (galls = bari-main); Bomb.—*Jhavmu-jhada*, *Jhan*, *Lei*, *Lai* (galls = *magiya-main*); Punj.—*Pilchi*, *Koa*, *Jhau* (galls = *mahin*, *bari-mahin*); Tam.—*Atru-sha-vukku*, *Kota-shavukku*; Tel.—*Eru-saru*, *Shiri-saru*; Pers.—*Shor-gaz* (galls = *gazmazaj*).

This shrub grows abundantly in India specially along the sandy localities. On its branches small tuberculous galls are produced by puncture by insects. These are globular in shape, are about the size of a nutmeg and have a bitter astringent taste. Most of the galls used in pharmacopoeial preparations are derived from Oak-galls which is the imported variety. The percentage of tannic acid in the Indian galls is large enough for their use in British Pharmacopoeia. A strong infusion of the galls is a good astringent gargle in stomatitis and sore throat. An infusion of the bark or the galls (4 to 5 ounces in a pint of water) is useful in doses of 1-2 ounces, in diarrhoea and dysentery; it is preferably combined with infusion of Chiretta. Powdered gall 1 to 2 drachm, opium $\frac{1}{2}$ drachm with an ounce of vaseline or any non-irritating oil forms an efficacious ointment in ulcerating piles and anal fissure in place of the official 'unguentum galle cum opio.'

TARAKTOGENOS KURZII King; see *Hydnocarpus kurzii* (King) Warb.

TARAXACUM OFFICINALE Weber

VERN.—Punj.—*Dudal*, *Baran*, *Kanphul*, *Dudli*, *Dudh batthal*, *Shamuke*; Bomb.—*Bathur*.

Taraxacum occurs in the temperate Himalayas and to some extent also in the Ootacamund Hills. Most of the taraxacum that is used in the preparation of the pharmacopoeial drugs is imported. The indigenous root is somewhat smaller than the imported variety but is effective. Powdered root in doses of 10-15 grains is believed to be a hepatic stimulant. Decoction of the root in doses of 1-2 ounces, combined preferably with podophyllum is useful in jaundice, hepatitis and indigestion.

TAXUS BACCATA Linn.

VERN.—Hind.—*Thuno*, *Birmi*, *Zirnub birmi*; Beng.—*Sugandh*, *Burmie*, *Bhirmie*; Bomb.—*Barmi* (leaves = *talispatr*); Punj.—*Birmi*, *Tung*, *Barma*, *Rikhai*, *Thona* (leaves = *birmi*); Khasia—*Dingsableh*; Kumaon—*Thaner*, *Thuner*, *Gallu*; Kash.—*Tung*, *Sungal*, *Postil*, *Chatung*.

It is a large tree sometimes attaining a height of about 100 feet growing in the temperate Himalayas, upper Burma and the Khasia Hills. To the leaves has been assigned a property somewhat similar to Digitalis. The leaves are available in most of the towns in Northern India and are used as sedative and emmenagogue. They are often prescribed in hysteria, epilepsy and nervousness. According to Dymock the leaves, to some extent, constitute the 'talispatra' (*Abies webbiana*) of the Sanskrit writers, but this seems doubtful.

TERMINALIA ARJUNA W. & A. (see page 421).

TERMINALIA BELERICA Roxb.

VERN.—Sans.—*Vibhitaki*, *Vipitakaha*, *Akasha*, *Bahira*; Hind.—*Bhaira*, *Bahera*, *Behra*, *Sagona*, *Bharla*, *Buhura*; Beng.—*Bohera*, *Baheri*, *Bhairah*, *Buhuru*, *Boyra*; Punj.—*Bahira*, *Bahera*, *Birha*, *Balela*, *Bayrah*; Bomb.—*Behara*, *Behada*, *Behda*, *Bherdha*, *Bakra*, *Bahudda*, *Yella*, *Goting*, *Yel*, *Behedan*, *Behasa*; Mar.—*Bherda*, *Baheda*, *Bahera*, *Sagwan*, *Beda*, *Yehela*

behada; Tam.—*Tani*, *Thani*, *Kattu elupay*, *Tanrik-kay*, *Tandi tonda*, *Chattu-elupa*, *Tamkai*, *Vallai-murdu*, *Tanikoi*; Tel.—*Tani*, *Tandi*, *Thandra*, *Thana*, *Tadi*, *Katthu-olupoe*, *Tandra kaya*, *Bahadrha*.

Myrobalan is common throughout India. Two forms occur in the bazars, one being twice the size of the other. In the Hindu medicine *T. belerica* was largely used in combination with *Emblica officinalis* and *T. chebula* in diseases of the liver and gastro-intestinal tract. The unripe fruit acts as a laxative and the dried ripe fruit as an astringent.

TERMINALIA CHEBULA Retz.

VERN.—Sans.—*Haritaki*, *Abhaya*, *Pathya*; Hind.—*Har*, *Harara* (tree), *Har*, *Pile-har*, *Bal-har*, *Zangihar*, *Kalehar* (fruit); Beng.—*Haritaki*, *Hora*; Punj.—*Har*, *Harrar*, *Hurh*, *Halela* (tree), *Har* (fruit); Bomb.—*Hirda*, *Harda*, *Har*, *Hirada*, *Bala hirade*, *Harle*, *Pilo-harle*, *Hardi*; Tam.—*Kada kai*, *Kaduk-kay* (tree), *Kaduk-kay*, *Kaduk-kaypinji* (fruit); Tel.—*Karaka*, *Kadukar*, *Kurka* (tree), *Karakkaya*, *Pinda karakkay* (fruit).

The bazar myrobalans have a pale buff colour, are oval in shape and have longitudinal ridges on the surface. They are composed of dry pulp with a stone-like kernel inside. The taste is astringent. Myrobalans are mild and efficient laxative. The following preparation is generally used as a household remedy: bruised myrobalans 6 in number, cloves 1 drachm, water 10 oz., boiled for ten minutes and strained. The dose should be administered early in the morning. Owing to the large amount of gallic acid the myrobalans contain, they can be used externally as a local application in chronic ulcers and wounds or as a gargle in stomatitis.

THESPESIA POPULNEA Soland. ex Corr.

VERN.—Sans.—*Gardha-bhanda*, *Parisa*; Hind.—*Parsipu*, *Pipal*, *Porush*, *Bhendi*; Beng.—*Pares pipal*, *Palas pipal*, *Porash*; Punj.—*Paras pipal*; Bomb.—*Bhendi*, *Palas piplo*, *Parsipu*, *Ran-bhendi*, *Parsachajhada*; Tam.—*Purasha*, *Purvarasam*, *Puarasu*, *Pursung*, *Poris*; Tel.—*Gangarenu*, *Gangaravi*, *Muniganga ravi*.

This tree grows along the sea coast of India and is cultivated to some extent in Madras. The leaves mixed with some bland oil are a favourite remedy in inflammatory swellings. The juice of the fruit is mentioned by Ainslie to be employed in various skin diseases specially in what is called 'Malabar itch'.

THEVETIA NERIIFOLIA Juss.; see *T. peruviana* (Pers.) Merr.

THEVETIA PERUVIANA (Pers.) Merr. (*T. neriifolia* Juss. and *Cerbera thevetia* Linn.) (see page 425).

TINOSPORA CORDIFOLIA Miers. (see page 426).

TRACHYSpermum AMMI (Linn.) Sprague (syn. *Carum copticum* Benth. & Hook. f.) (see page 93).

TRIBULUS TERRESTRIS Linn. (see page 430).

TRICHOSANTHES CUCUMERINA Linn.

VERN.—Sans.—*Patola*; Hind.—*Jangli-chi-chonda*; Beng.—*Banpatol*; Punj.—*Gwal*, *Kakri*; Bomb.—*Jangli-padavala*, *Ran-parul*, *Kadu-padavala*, *Ranachapadavali*, *Patola*; Tam.—*Kattup-pudal*, *Pudel*; Tel.—*Adavipotla*, *Patolamu*, *Cheti-potla*.

TRICHOSANTHES DIOICA Roxb.

VERN.—Sans.—*Patola*; Hind.—*Parvar*, *Palval*; Beng.—*Potol*; Punj.—*Palwal*; Bomb.—*Potala*; Tam.—*Kombu-pudalai*; Tel.—*Kommu-potla*.

The fruit of the species 'patola' is described by the Sanskrit writers as febrifuge, laxative and antibilious. In Bengal the fruit of *T. dioica* is considered to be the 'patola' of the Hindu physicians. The juice of the leaves and the fruit is mentioned as a cholagogue and aperient. The root is a drastic purgative.

TYLOPHORA ASTHMATICA W. & A.; see *T. indica* (Burm. f.) Merr.

TYLOPHORA INDICA (Burm. f.) Merr. (syn. *T. asthmatica* W. & A.).

VERN.—Hind.—*Jangli pikuan*, *Antamul*; Beng.—*Anto-mul*; Bomb.—*Pitmari*, *Kharaki-rasna*, *Anthamul*, *Pitakari*; Tam.—*Nach-churuppan*, *Nanjamurich-chan*, *Nay-palai*; Tel.—*Verri-pala*, *Kukka-pala*.

The plant is very commonly met with in low and sandy localities. It has been used extensively in indigenous medicine and for this purpose the root and the leaves are preferred. The root has attached to it many tender fibrils, sometimes about 20 in number. Ten to fifteen grains of the dried leaves or root 2-3 times daily are said to be useful in dysentery. It is also useful as an expectorant in chronic bronchitis.

UNCARIA GAMBIR (Hunter) Roxb.

VERN.—Hind.—*Kath kutha*; Bomb.—*Chinai katha*; Tel.—*Ankudu kurra*; Malay—*Gambir*.

Gambir is an extract from the stem and leaves of *U. gambir*. It is imported into the markets of India from Java, Sumatra, Penang and Singapore. It is known as 'pale catechu' to distinguish it from *Acacia catechu* which is indigenous to India. All the preparations of catechu in the British Pharmacopoeia are derived from this imported source. It has a bitter astringent taste and is a well-known local astringent. The official tincture diluted with water can be used as a gargle in sore throat, stomatitis, etc. Internally, in combination with chalk, kino and opium, it is a useful preparation in diarrhoea and cholera.

URGINEA INDICA Kunth (see page 251).

VALERIANA WALLICHII DC. (see page 253).

VATERIA INDICA Linn.

VERN.—Hind.—*Sufed-damar*, *Kahruba*; Beng.—*Chundrus*; Bomb.—*Rail*; Tam.—*Vellai-kunrikam*, *Vellai-damar*, *Velli kundricun*, *Painipishin*, *Vellai-kungiliyam*, *Dhup maram*; Tel.—*Dupa-damaru*, *Tella damaru*, *Dupada*; Malay—*Payana*, *Vella-kunturukkam*, *Painipasha*, *Vella kondrikam*.

The resin from *V. indica* is white 'dammar'; the black variety is obtained from *Canarium strictum*. The resin forms a good emollient for plasters and ointment basis. The oil obtained from the seeds is a reputable local application in chronic rheumatic inflammation of the joints.

VERNONIA ANTHELMINTICA Willd.; see *Centratherum anthelminticum* (Willd.) Kuntze

VIOLA ODORATA Linn.

VERN.—Hind.—*Banafshah*; Beng.—*Banosa*; Bomb.—*Bonafshah*, *Baga banosa*, *Banaphsa*; Tam.—*Vayilettu*.

The flowers and the root of *V. odorata* are known in the bazar as 'banafshah'. It is met with in Kashmir at an altitude of about 5000 feet from where it is brought to the plains and is sold as a valuable remedy in various ailments. It is considered to be a diuretic, diaphoretic and aperient. An emetic principle named *violin* was isolated from it, but O'Shaughnessy found the drug ineffective in dysentery. Mohideen Sheriff advocated the use of the drug in fever to allay the distressing symptoms. An infusion (2 drachms of the flower in a pint of warm water) is given as a cooling mixture in fever in doses of 1-2 ounces.

VITEX NEGUNDO Linn.

VERN.—Sans.—*Sveta-surasa*, *Vrikshaha*, *Nirgundi*; Hind.—*Sanbhalu*, *Nirgandi*, *Nisinda*, *Mewri*, *Sambhalu*; Beng.—*Nishinda*, *Samalu*, *Nirgundi*; Punj.—*Marwan*, *Maura*, *Banna*, *Torbanna*, *Swanjan*, *Mawa*, *Amalu* (root & leaves), *Bari* (fruit); Bomb.—*Nirgundi*, *Katri*, *Shiwari*, *Nisinda*, *Nargunda*, *Lingur*, *Nirgur*; Tam.—*Vellai-noch-chi*, *Nochchi*; Tel.—*Tella-vavili*, *Vavili*, *Nalla-vavili*.

VITEX PEDUNCULARIS Wall. (see page 435).

VITEX TRIFOLIA Linn.

VERN.—Sans.—*Surasa-vrikshaha*, *Jala-nirgundi*; Hind.—*Pani-ki-sanbhalu*, *Sufed-sanbhalu*; Beng.—*Panisamalu*; Tam.—*Nir-noch-chi*, *Shiru-noch-chi*; Tel.—*Niru-vavili*, *Shiruvavili*.

V. negundo and *V. trifolia* are both common bazar drugs and the properties are considered to be similar. The leaves are heated and are applied to painful and rheumatic swellings. Macerated leaves made into a paste with water are given as a cooling application on the forehead in headache.

VITIS QUADRANGULARIS Wall.; see *Cissus quadrangularis* Linn.

WRIGHTIA ANTIDYSENTERICA Garh. (syn. *Holarrhena antidysenterica* Wall.) (see page 342).

ZINGIBER OFFICINALE Rosc. (see page 255).

ADDENDUM

A good amount of work on Indian medicinal plants has appeared in different journals since the manuscript was sent to the press. This has been incorporated below.

Abroma augusta Linn.

The roots contain some alkaloidal bases, reducing sugars and some phytosterols. Glycosides have not been found. An alkaloid, abromine and a phytosterol have been isolated. (Srivastava, G. P. and Basu, N. K., 1956, *Indian J. Pharm.*, 18, 472).

Acacia berlandieri Benth.

The plant contains a toxic principle. The compound is identified as *n*-methyl β -phenylethylamine. (Camp, B. J. and Lyman, C. M. 1956, *Amer. Pharm. Ass.*, 45, 719).

Acorus calamus Linn.

The alcoholic extracts of the plant has been shown to possess sedative and analgesic properties; it causes a moderate depression in the blood pressure and respiration. The water-soluble fraction of the dealcoholized extract produced a relaxation of isolated intestines and negative inotropic action on frog's heart. Antiepileptic activity was not present. The insecticidal activity of solvent extracts and steam volatile principle of the rhizomes of *A. calamus* against the common house flies is quite marked. The insecticidal activity of the oil and the extract appears to be due to the presence of the transisomer of asarone. (Agarwal, S. L., Dandiya, P.C., Singh, K. P. and Aroa, R. B., 1956, *J. Amer. Pharm. Ass.*, 45, 655; Dixit, R. S., Perti, S. L. and Ranganathan, S. K., 1956, *J. Sci. Industr. Res.*, 15C, 16).

Adhatoda vasica Nees.

The seeds of the plant contain 25.8 per cent. of a deep yellow oil containing glycerides of arachidic 3.1, behenic 11.2, lignoceric 10.7, cerotic 5.0, oleic 49.9, and linoleic 12.3 per cent. and β -sitosterol. (Handa, K. L., Ishwar Chandra and Vasudev, 1956, *J. Sci. Industr. Res.*, 15B, 612).

Aglala odorotissima Blume.

The essential oil from the seeds contains aromadendrene as the chief constituent, cineol, α -terpinene, citral and a sesquiterpene. (Baslas, K. K., 1955, *J. Ind. Chem. Soc.*, 32, 445).

Ailanthus malabarica DC.

A crystalline steroid designated as malanthin, has been isolated from the bark of this plant. A tentative partial structure has been assigned to malanthin on

the basis of its ultraviolet and infra red absorption spectra and other data. (Rastogi, R. P. and Dhar, M. L., 1957, *J. Sci. Industr. Res.*, 16B, 74).

***Albizzia amara* Boivin.**

The fixed oil from the seeds of this plant contains myristic acid 1.53, palmitic acid 7.60, stearic acid 4.30, arachidic acid 2.17, behenic acid 0.58, lignoceric acid 0.43, oleic acid 31.34, and linoleic acid 45.55 per cent. The unsaponifiable fraction was found to contain β -sitosterol. The oil is a semi-drying oil. (Ishwar Chandra, Sud, R. P. and Handa, K. L., 1956, *J. Sci. Industr. Res.*, 15B, 196).

***Anamirta cocculus* (Linn.) W. & A.**

Fatty acids of the seed fat obtained from the plant consist of palmitic 6.1, stearic 47.5, oleic 43.3 and linoleic 3.12 per cent. The glyceride composition of the fat as determined by the acetone permanganate oxidation method is: tri-saturated (GS_3) 9.77 per cent; disaturated mono-unsaturated (GS_2U) 41.55 per cent.; mono-saturated di-unsaturated (GSU_2) 48.78 per cent. and tri-unsaturated (GU_3) nil. The unsaponifiable matter from the fat contains sitosterol. (Kasturi, T. R. and Iyer, B. H., 1954, *J. Ind. Chem. Soc.*, 31, 623).

***Anethum graveolens* (Dill).**

The plant, originally a native of Southern Europe, is an annual herb cultivated on commercial scale in Germany and the Netherlands, and on a smaller scale in England. It is not found in India, but an allied plant, *Anethum sowa*, containing 3 to 3.5 per cent. of an essential oil and having different physico-chemical properties and constituents, is cultivated as a winter crop in many parts of India. Dill oil is extensively used in medicine in the treatment of a large variety of gastrointestinal disorders particularly in infants. As the Indian dill oil, derived from *Anethum sowa*, lacks carvone and is not medicinally effective, large quantities of foreign dill oil are annually imported from abroad. In order to introduce this plant into India, seeds were obtained through the courtesy of Dr. W. O. James of Oxford University and sown broadcast in well prepared beds in November. The seeds germinated in two week's time and the plants bore flowers by the end of February. The crop was harvested in the month of April. Seeds collected from acclimatised plants were again sown and the cultivation considerably extended.

CULTIVATION.—Although a plant of temperate climate, dill can also be cultivated in the plains of northern India as a winter crop. It shows best growth on fertile loamy soil dressed with farmyard manure. It has been observed that the plants grown from seeds sown broadcast or in rows show more vigorous growth than the plants raised from the seed first sown in the nursery and later transplanted in the field. Fertilizers such as chillian nitrate, superphosphate and lime have been observed to produce an adverse effect on the growth of the plants. In cooler climates the seed is sown early in spring and the seed matures in the

following autumn in September or October. In the plains, where the summers are very hot, the seed is sown in September and the fruit matures in April when the crop is harvested. The seed should be sown in rows 1 to 2 ft. apart. The plants should be thinned out when 3 in. high, leaving a distance of 6 to 15 inches between plants in the row. A better seed crop is obtained if the plants are not too crowded. The best method of harvesting the crop is to mow the plants when the earliest seed is ripe. In the dry weather, this should preferably be done early in the morning when the plants are damp with dew. The harvested material should be left in the field in cocks to dry before the seed is threshed out.

Observations made on the plants grown in our experimental stations in Jammu and Kashmir show that dill can profitably be grown in this area as commercial crop. It yields nearly 2.5 to 3.0 per cent. of dill oil containing 50 to 62 per cent. corvone, which is up to the official standards laid down in Pharmacopoeias. The yield on an average is 400 lb. of seed per acre. The yield and quality of the oil obtained here compares well with those obtained in England and Hungary. Dill has got very well acclimatised in this region and can be grown as a summer crop in Kashmir Province and as winter crop in Jammu Province. Its cultivation is being extended on a large scale in the drug farms and it is hoped that a substantial part of the country's requirement of dill will be met from the production in this area. (Handa, K. L., Hct Singh, Sobti, S. N., 1955 *Indian J. Pharm.*, 17, 256).

Anisochilus carnosus Wall.

The essential oil from the leaves and stem of this plant though possessing *in vitro* antihistaminic activity, does not inhibit the anaphylactic response of the sensitized guinea-pig uterus to egg white; the oil diminishes spontaneous movements, causes relaxation of the intestinal musculature and completely inhibits the contracture due to the antigenic stimulation of the sensitized ileum. The possibility of this oil being useful to relieve the intestinal manifestations of allergy is suggested. (Sirsi, M. and Rama Rao, R., 1956, *Indian J. Med. Res.*, 44, 283).

Asteracantha longifolia Nees and Strobilanthes auriculatus Nees

Lupcol has been isolated from the roots of *Asteracantha longifolia* and *Strobilanthes auriculatus*. Hentriacontane has been isolated from the leaves of the former. (Govindachari, T. R., Nagarajan, K. and Pai, B. R., 1957, *J. Sci. Industr. Res.*, 16B, 72).

Brunella vulgaris Linn.

The essential oil from this plant consists mainly of *d*-camphor and *d*-fenchone and traces of fenchyl alcohol. (Baslas, K. K., 1955, *J. Ind. Chem. Soc.*, 32, 228).

Caesalpinia digyna Rottle.

The pods are rich in tannins and contain a phenolic substance vakerin. (Chaudhry, G. R., Sharma, V. N. and Dhar, M. L., 1954, *J. Sci. Industr. Res.*, 13B, 147).

Calophyllum inophyllum Linn.

A lactone, calophyllolide, a related acid, calophyllic acid, a new polyene acid, inophyllic acid, and an essential oil fraction have been isolated from the non-glyceridic portion of the oil obtained from the nuts of *C. inophyllum* Linn. Inophyllic acid has also been found to be present in the stem bark of the plant. (Mitra, C., 1957, *J. Sci. Industr. Res.*, 16B, 120).

Cassia fistula Linn.

The aqueous extract of the pulp of *Cassia fistula* exhibited a slightly lower antibacterial activity than its dealcoholized extracts as observed by the inhibition of the growth of *Micrococcus pyogenes* var. *aureus*, *Micrococcus pyogenes* var. *albus*, *Micrococcus citreus*, *Corynebacterium diphtheriae*, *Bacillus megatherium*, *Salmonella typhi*, *Salmonella paratyphi*, *Salmonella schottmülleri* and *Escherichia coli*. (Patel, R. P., and Patel, K. C., 1956, *Indian J. Pharm.*, 18, 107).

Centella asiatica (Linn.) Urban

The alcoholic extract of the plant on investigation gave triterpenic constituent, indocentoic acid, which appears to be isomeric with centoic acid isolated from the Ceylonese variety. The plant from Ceylon has been found to contain salts, sugars, essential oils and a nitrogen and sulphur-containing pectin. The most characteristic components are, however, three polyhydroxy triterpenic acids, viz., centic, centoic and centellic acids, and a water-soluble glycoside, centelloside, the aglycone of which is identical with centellic acid. (Bhattacharyya, S. C., 1956, *J. Ind. Chem. Soc.*, 33, 579, 893).

Cerbera odollam Gaertn.

The seed kernel of *Cerbera odollam* Gaertn. on extraction with solvents and fractionation yields a number of crystalline and amorphous glycosides. The principal crystalline glycosides have been identified as cerberin, neriifolin and thevetin from their properties and also by direct comparison with glycosides obtained from *Thevetia neriifolia* Juss. (Rangaswami, S. and Venkata Rao, E., 1957, *J. Sci. Industr. Res.*, 16B, 209).

Chelidonium majus Linn.

The supraterranean parts of this plant yielded 0.11 per cent. of *dl*-tetrahydrocoptisine as the dominant alkaloid with smaller quantities of chelidonine and protopine. (Bandelin, F. J. and Malesh, W., 1956, *J. Amer. Pharm. Ass.*, 45, 702).

Chonemorpha macrophylla G. Don.

The root bark contains 3.03 per cent. of total alkaloids consisting mainly of chonemorphone, a saturated, quarternary alkaloid, a neutral amorphous substance, an acid resin and unsaponifiable matter. (Das, K. G. and Pillay, P. P., 1954, *J. Sci. Industr. Res.*, 13B, 602).

Cissampelos pareira Linn.

The roots of *Cissampelos pareira* from Kashmir yields two alkaloids, hayatin and hayatinin and *d*-quercitol. The roots of plants from Pilibhit (U.P.) however, contain hayatin and *l*-bebeerine, but no hayatinin or *d*-quercitol. Both samples give an essential oil and a sterol. The methiodide of hayatin has been found to possess powerful neuromuscular blocking property comparable to that of *d*-tubocurarine chloride. The propagation of this plant by root cuttings has been successfully tried. (Bhattacharji, S., Sharma, V. N. and Dhar, M. L., 1956, *J. Sci. Industr. Res.*, 15B, 363; Srivastava, G. S., 1956, *Sci. & Cul.*, 21, 601).

Citrullus colocynthis Schrad.

From the juice of bitter apples α -claterin, citrulluin, citrulluen and citrulluic acid have been isolated. (Siddiqui, R. H., Siddiqui, I. R. and Muhammad, S., 1955, *J. Ind. Chem. Soc.*, 32, 669).

Coreopsis tinctoria Nutt.

The ray flowers of the plant contain crystals of two anthochlor pigments. (Shimokoriyama, M., 1957, *J. Amer. Chem. Soc.*, 79, 214).

Crataeva religiosa Hook f. & Thoms. non Forst. f.

Two colourless crystalline products, one of which is identical with lupeol and a small quantity of β -sitosterol have been isolated from the stem bark. (Bhandari, P. R. and Bose, J. L., 1954, *J. Sci. Industr. Res.*, 13B, 773).

Crinum defixum Ker-Gawl.

A crystalline substance has been isolated from the seeds of this plant and identified as lycorine. (Rangaswami, S. and Venkata Rao, E., 1955, *Indian J. Pharm.* 17, 140).

Crinum latifolium Linn.

A crystalline lycorine like substance, has been isolated from the seeds. Lycorine has also been isolated from the bulbs of *C. defixum*. (Rangaswami, S. and Suryanarayana, M., 1955, *Indian J. Pharm.*, 17, 229; Rangaswami, S. and Venkata Rao, E., 1955, *Curr. Sci.*, 24, 25).

Crotalaria juncea Linn.

The seeds of the plant by ethanolic extraction, give riddelline, seneciphylline and senecionine by subsequent methanolic extraction. A new alkaloid designated as junceine has also been obtained together with trichodesmine an alkaloid which has previously been isolated from *Trichodesma incanum*. An optically inactive amino acid, identified as β -hydroxy-N-methyl-DL-norvaline A is also present. (Adams, R. and Gianturco, M., 1956, *J. Amer. Chem. Soc.*, 78, 1919).

Cucurbita pepo Linn.

The seeds of the plant yield an oil containing glycerides of palmitic acid 9.5, stearic acid 7.93, oleic acid 38.99 and linoleic acid 43.49 per cent. (Narayana-murthy, N. L. and Iyer, B. H., 1954, *Indian J. Pharm.*, 16, 148).

Curcuma longa Linn.

Sodium curcumin, the sodium salt of the pigment curcumin, isolated from *Curcuma longa*, has been found to be an active choleric, inducing nearly 100 per cent. increase of bile production in anaesthetized dogs, in doses non-toxic to the animal. The essential oil and some of its fractional distillates also induce choleresis but to a lesser extent than the pigment. (Ramprasad, C. and Sirsi, M., 1956, *J. Sci. Industr. Res.*, 15C, 262).

Digitalis lanata Ehrh.

Kashmir grown leaves yields pure β -acetyl-digoxin and tigonin. (Ranga-swami, S., Subramanian, S. and Venkata Rao, E., 1955, *Indian J. Pharm.*, 17, 253; Kier, L. and Gisvold., O., 1956, *J. Amer. Pharm., Asso.*, 45, 581).

Dioscorea deltoidea Wall.

Cortisone, a recently discovered steroid hormone has proved of great value in the treatment of a large variety of diseases, particularly in rheumatic diseases, certain opthalmic disorders, allergic states and in idiopathic thrombocytopenic purpura. Cortisone is prepared commercially by partial synthesis of bile acids (deoxycholic acid) from ox bile and these are still the principal sources. The supply from this source is naturally limited. Cortisone can now be prepared by partial synthesis from naturally occurring plant steroids which are available in sufficient quantity and could be used as starting material for building up the molecule of cortisone. For the last many years, a search for a cheaper and potentially unlimited plant source of a suitable raw material for the production of cortisone has been going on. Sarmenogenin the cardiac aglycone from the seeds of African *Strophanthus sarmentosus* attracted the attention of scientists. As the percentage of aglycone present was very small, attempts to use it for the large-scale commercial production of cortisone were not very successful. Hecogenin, present in the Agave and Sisa plants has also been tried as the starting material for this purpose. Among the various raw materials suggested from time to time for the preparation of cortisone, steroid sapogenins appear to be the best and the most suitable starting materials. Recently, diosgenin derived from various species of *Dioscorea* has come into use. Taking into consideration various factors such as availability, ease of conversion, etc., diosgenin appears to be the best starting material for the preparation of cortisone and other steroid hormones. Diosgenin is the principal sapogenin of the glycoside (saponin) of the yams of plants belonging to the family Dioscoreaceae. Hooker reported 25 species of *Dioscorea* growing in India. Chakravarti and co-workers investigated 19 species out of these, and found that the tubers of *D. deltoidea* and

D. praseri contain an exceptionally high percentage of sapogenin, i.e., 3.33 per cent. and 2.1 per cent. respectively.

D. praseri is indigenous to the E. Himalayas and grows wild in Bengal, Assam, Sikkim and Bhutan. *D. deltoidea* grows wild in the N.-W. Himalayas and commonly occurs in the foot-hill areas of Jammu and Kashmir State. It is known in Punjab as 'Kitra' and in Kashmir as 'Krish' being used locally for washing wool and hair and for killing lice. It grows in Gulmarg and Pahalgam in Kashmir and at Katra, Reasi, Batote, Sanasar and Bhadrawah in Jammu Province. Ishwar Chander and co-workers studied the plants growing in the different parts of the State observed that the best quality of *D. deltoidea* containing upto 4.8 per cent. of diosgenin are found in wild state in the Katra and Pahalgam areas of Jammu and Kashmir State. The best period for collection was found to be in the months (Jan.-April) when the tubers are dormant and the aerial portion of the plant has withered.

CULTIVATION.—The tubers from wild plants from Katra were collected and propagated in our Field Research Stations at Jammu (900 ft.) and Katra (3,000 ft.). Propagation was carried out by putting the sprouting buds of the rhizomes in prepared soil, (March-April) in the rainy season (July-August). The plant prefers light sandy loam and a warm temperate climate which permits a long growing season. The soil is best manured with old well-rotted leaf mould before planting. Plants should be put in at a distance of one foot in rows 2 ft. apart. These are provided with support of sticks on which the vines can climb. The plant raised in spring and rainy season at both the localities progressed best and rhizomes weighing between 7 and 10 ounces were obtained after 12 months of growth. The plants flower earlier in spring at lower altitudes such as that of Jammu. At higher altitudes, in Kashmir the plant flowers in June-July and bears fruit in September-October. The plant can also be propagated by stem cuttings. New wood, which will not wilt, is divided into single node cuttings, consisting of a leaf with the axillary bud and a short portion of the stem. The cuttings are placed in coarse sand and watered immediately; they are shaded and protected from the direct sun. In about three weeks time the rooted cuttings are produced, which are then planted in the field. The tubers from one year old plants showed 3.6 per cent. diosgenin, and this is expected to increase progressively with the maturity of the plants. (Barua, A. K., (Mrs.) Chakravarti, D. and Chakravarti, R. N., 1956, *J. Ind. Chem. Soc.*, 33, 799; Ishwar Chandar, Handa, K. L. and Kapoor, L. D., *Indian J. Pharm.*, 1955, 17, 142).

***Eclipta alba* Hassk.**

It contains wedelolactone. (Govindachari, T. R., Nagarajan, K., and Pai, B. R., 1956, *J. Sci. Industr. Res.*, 15B, 664).

***Entada scandens* Benth.**

It contains a sulphur containing glycoside, saponins A and B which give sugar, glucose, galactose, xylose and arabinose. (Rangaswami, S., and Subba

Rao, V., 1954, *Indian J. Pharm.*, 16, 152 ; Datta, N. L., 1954, *J. Sci. Industr. Res.*, 13B, 672).

***Erechtites hieracifolia* Rafin ex DC. and *Senecio jacobaea* Linn.**

The alkaloid hieracifoline, isolated by Manske from *Erechtites hieracifolia*, is a mixture. By employing a partition chromatographic procedure the two compounds, namely, senecionine and seneciophylline, were separated. From the alkaloid 'jacobine' isolated by Manske from *Senecio jacobaea*, senecionine, seneciophylline and a third alkaloid which is identical with Bradbury's and Culvennor's jacobine were obtained. These three components in different ratios were present in a sample of *Senecio jacobaea* Linn. of Norwegian origin. (Adams, R., and Gianturco, M., 1956, *J. Amer. Chem. Soc.*, 78, 398).

***Euphorbia acaulis* Roxb.**

The roots of the plant contain a sterol and two neutral crystalline substances myricyl alcohol and a sterol glycoside. (Khanna, N. M., 1954, *Indian J. Pharm.* 16, 110).

***Glycyrrhiza glabra* Linn.**

Glycyrrhiza has been successfully raised in Jammu and Kashmir and the roots obtained from the cultivated plant show good percentage of active principle. The drug produced came up to the official standards. (Kapoor, L. D., Handa, K. L., and Tej Singh, 1955, *Indian J. Pharm.*, 17, 231).

***Hemidesmus indicus* R.Br.**

The plant contains β -sitosterol. (Chatterjee, R. C. and Bhattacharyya, B. K., 1955, *J. Ind. Chem. Soc.*, 32, 485).

***Hyoscyamus muticus* Linn.**

The plant contains besides hyoscyamine and atropine 0.02 per cent. hyoscine and a large amount of potassium chloride. (Handa, K. L. and Abrol, H. L., 1954, *J. Sci. Industr. Res.*, 13B, 221).

***Jatropha glandulifera* Roxb.**

The bark contains three substances one of which is glucose. The seed oil contains myristic acid 2.338, palmitic acid 14.5, stearic acid 5.972, oleic acid 34.19, and linoleic acid 43.0 per cent. in terms of methylesters. It obeys the rule of even distribution. (Sheth, M. C. and Desai, C. M., 1954, *Sci. & Cult.*, 20, 243; Sheth, M. C. and Desai, C. M., 1954, *J. Ind. Chem. Soc.*, 31, 407).

***Lawsonia inermis* Linn.**

The essential oil from the flowers of this plant contain α -ionone and β -ionone as the chief components. (Baslas, K. K., 1954, *J. Ind. Chem. Soc.*, 31, 705).

Luffa aegyptiaca Mill.

The powdered seeds contain a bitter substance amarin. (Rangaswami, S. and Sambamurthy, K., 1954, *Indian J. Pharm.*, 16, 225).

Melodinus monogynus Roxb.

A bitter β -glycoside and two sterols have been isolated. The bitter glycoside melodin yields on hydrolysis aglucone, melodinidin. (Chatterji, S. K., Sharma, V. N. and Dhar, M. L., 1954, *J. Sci. Industr. Res.*, 13B, 546).

Mentha arvensis Linn.

Oil of peppermint produced in the United Kingdom is obtained by steam distillation of the flowering herb of *Mentha piperita* Linn. This grows in Europe and is now being cultivated in England, America, Russia and many other parts of the world. Japanese and Chinese peppermint oils are obtained from *Mentha arvensis*. This plant is known botanically in Japan as *Mentha arvensis* Linn., subsp. *haplocaly* Briquet var. *piperascens* Homes. The plant is extensively cultivated in Japan and yields the bulk supply of menthol and Japanese peppermint oil which is exported to all parts of the world. Before World War II Japan used to export about 70 per cent. of the world's total supply of menthol and dementholized mint oil, the balance being supplied by China and other countries. There are a number of species of *Mentha* which either grow in a state of nature or are cultivated in India but none of these yields the peppermint oil of medicinal value. The necessity for introduction and cultivation of *M. piperita* for the distillation of peppermint oil was felt in India as early as 1881 and the plant was raised in the Nilgiris and Mysore. Recently it has also been raised in the Forest Research Institute, Dehra Dun, but the oil obtained at either of these localities was not up to the official standard. In order to introduce the Japanese mint (*Mentha arvensis* Linn.) into the Jammu and Kashmir State, a few live rooted suckers were obtained from Japan through the courtesy of UNESCO and planted in nursery beds at different places in the State. The plant showed very vigorous growth in Jammu and Katra and bore flowers in July. The plants yielded 2 to 2.4 per cent. oil containing nearly 70 per cent. menthol. With increasing acclimatization of the plant the oil yield has now risen to between 3 and 4 per cent.

CULTIVATION.—As the plants raised in Jammu and Katra nurseries faired well and gave good percentage of oil and menthol, the propagation of the plant was extended in these localities in areas which could be liberally irrigated. For planting, rooted suckers were taken from old but still vigorous plants. After ploughing and planking the field, the young juicy roots are cut into 3 or 4 in. pieces and planted in rows. The planting of rooted suckers was done in early spring in Jammu and Katra. It was also observed that rooted suckers would do well when planted during the rainy months of July and August or in October and November in Jammu and Katra. The rooted suckers when planted in March in Jammu under irrigated conditions propagated well and flowered in

July when the first flush of the crop could be harvested. The yield was 200-300 md. per acre of green herb, which contained 45 per cent. stems and 50 per cent. of leaves. The herb contains 75 per cent. moisture. The field was irrigated and weeded at regular intervals when in about two month's time it showed very vigorous growth. The plant again flowered in October when the second flush could be harvested and the yield was about 100 md. or so of green herb per acre with nearly 75-80 per cent. moisture and containing 30 per cent. of stems. The total yield of the fresh herb works out to be about 300-450 md. per acre or about 75-110 md. of dry herb. The proportion of stems to leaves for the two harvests is approximately 1:2.

HARVESTING.—The harvesting of *Mentha arvensis* requires special care because improper harvesting may seriously lower the quality of the oil. Harvesting of the crop is done when the plants are in full bloom. According to the climatic conditions prevailing in the locality, one or two flushes of the crop may be harvested in July-August and October when the plant is in blossom. It is advisable to cut the crop by sickles in the morning on a bright sunny day when the dew has disappeared. The cut plants are tied into small bundles and hung in open or under sheds and dried. The number of days required for drying vary in summer and autumn, the best state of dryness being when the weight of the fresh plant is reduced to one-third or one-fourth the original weight but is not completely crisp. Care is taken to prevent the leaves from falling off during drying process. Sometimes the plant is dried in sun but this is considered unsatisfactory because of the loss of oil due to resinification and evaporation. The bundled material must not be allowed to ferment. The plant gives good crop in the second and third year and then the yield of the oil diminishes and it is economical to uproot the whole crop in the fourth year and replant afresh after rotation.

SOIL, IRRIGATION AND CLIMATIC REQUIREMENTS.—The plant in its natural habitat is reported to do fairly well in good sandy or loamy soil rich in humus. A well drained fertile soil and little rain during harvesting period is considered an ideal condition for its cultivation. If planted on a good sandy soil with rains in spring and ample sunshine in summer, the plant develops high menthol contents. For normal cultivation in the fields, six ploughings with common indigenous plough will make the soil fit for planting the rooted suckers. The land should be worked well by deep ploughing and cleared of any roots or bushes etc. This facilitates easy and quick propagation of suckers. Mint requires liberal irrigation and well drained soils. Due to its profuse vegetative growth the plant has been observed to survive even after it has been submerged in monsoon water for a couple of days. Liberal irrigation after planting and harvesting are beneficial for its propagation and healthy growth. Care should be taken against excessive drainage.

MANURING AND INTER-CULTURE.—Japanese mint when planted in rows in the first year is known as 'row mint' and required weeding and hoeing at least twice for its healthy growth. In the second year the plant propagates so

vigorously by its suckers that it becomes a unit field without any distinction of rows. It is then known as Meadow mint. For purposes of aerating the soil, inter-culture by means of a cultivator or ploughing the field after harvesting the crop is necessary. *Mentha* responds favourably towards organic manures and it would be advisable to apply organic manure (farmyard manure or compost at the rate of 12 tons per acre in the field) before planting. Green manuring may also be done before the mint is planted. It has been reported that subsequent dressings of mixture of inorganic fertilizers twice a year in the following proportion gives very good yield of the crop: ammonium sulphate 22 lb., superphosphate 200 lb. and potassium sulphate 200 lb. Superphosphate mixed with organic manures also gives good results. For purposes of rotation, if green manuring is not possible, some other leguminous crop may be sown, preferably *Casia angustifolia* (senna) which yields the senna leaf and senna pods of medicinal value. Growing of beans has also been recommended. These crop rotations tend to increase the percentage of oil and menthol in the plant.

DISTILLATION.—The yield of oil obtained by distilling the dry leaves was 2.0 per cent. The stems from the dry herb were removed by beating because they constituted 40-50 per cent. of the plant and contain only traces of oil. For distillation, an ordinary field distillation still was employed. It was charged with dry and fresh herb separately. The dried material yields oil more readily and the distillation was complete within 1½-2 hr. while the fresh material took 3-4 hr. for complete recovery of the oil. It is advantageous and economical to remove the stems and distill only the dried leaves which are less bulky and yield the oil more readily and in a shorter time. Fuel consumption is also less. The oil obtained contained a lot of suspended dust and other mucilaginous matter which was separated. The golden yellow oil having characteristic peppermint smell and a slightly bitter taste was obtained and contained 70-80 per cent. menthol. In a field distillation still (capacity 150 gal.) about 1½ md. of dry leaves can be distilled at a time. Working the still for 24 hours, 12-15 mds. of dry leaves can be handled in eight or nine batches. Menthol from the oil is separated in a crystalline form on cooling the oil to a low temperature. By repeated chilling and filtration nearly 51 per cent. of the menthol present in the oil can be separated out. The separated menthol spread out in trays and dried at ordinary temperature when traces of adhering oil are also removed.

Peppermint oil of medicinal value contains 45 per cent. of menthol and in practice only that much menthol is removed from the natural oil so that the remaining oil contains 45-50 per cent. menthol. The dementholized oil can then be used as peppermint oil. The natural oil obtained yielded on an average 40-50 per cent. menthol and 50-60 per cent. dementholized oil. Menthol which was obtained in well-defined crystals (m.p. 41°C.) gives a residue (0.03 per cent.) when heated at 105°C. This compares very well with the official product. The oil from the plant has been systematically investigated and it has been found to contain menthyl acetate 24.4, free menthol 44.8, menthone 24.6 and hydrocarbons 6.2 per cent.

The above investigations show that *Mentha arvensis* is now well acclimatized

in the Jammu area and yields over 2 per cent. of oil containing 70-80 per cent. of menthol. The yield of both the peppermint oil and menthol from the natural oil is very encouraging and the yield of the crop per acre under the climatic conditions prevailing here also compares favourably with yields obtained by cultivators in Japan and Brazil. Large scale cultivation of this plant in drug farms has been undertaken but it is felt that if along with this its cultivation is also taken up by the local peasants in this area on cottage industry scale (as is being done both in Brazil and Japan), this area can meet to a great extent the country's demand for both peppermint oil and menthol. Demonstration centres are being opened and efforts are being made to induce the peasants in the countryside to take up its cultivation in their spare holding. (Chaudhari, S. S. and Handa, K. L., 1956, *Indian J. Pharm.*, 18, 421 ; Kapoor, L. D., Handa, K. L. and Chopra, I. C., 1953, *J. Sci. Industr. Res.*, 12A, 311).

***Mentha rotundifolia* Linn.**

A new ketone has been isolated from the oil of *Mentha rotundifolia*. It is indicated that this ketone is the same as has been isolated from Indian spearmint and from species of Lippia oils (Reitsema, R. H., 1956, *J. Amer. Chem. Soc.*, 78, 5022).

***Mentha sylvestris* Linn.**

From a species of mint, *Mentha sylvestris*, there has been obtained a ketone, the structure of which has been shown to be *l*-piperitone oxide. (Reitsema, R. H. and Varnis, V. J., 1956, *J. Amer. Chem. Soc.*, 78, 3792).

***Momordica charantia* Linn.**

The fatty acid composition of the oil from the seeds of this plant from Karela is α -elaeostearic acid 46.7, linoleic acid 7.7, oleic acid 15.8 and stearic acid 29.8 per cent. (Verma, J. P. and Aggarwal, J. S., 1956, *J. Ind. Chem. Soc.*, 33, 357).

***Moringa pterygosperma* Gaertn.**

Pterygospermin obtained in crystalline state inhibits in a concentration of 10^{-5} (1 in 100,000) growth of actively growing moulds and fungi such as *Alternaria solani*, *Fusarium*, *lycopersici*, *Rhizopus nigricans*, *Aspergillus niger*, *A. Fumigatus*, *Penicillium notatum* and *P. chrysogenum*, Q-176. (Kurup, P. A. and Narasimha Rao, P. L., 1954, *Ind. J. Med. Res.*, 42, 85).

***Mucuna pruriens* DC.**

The seeds contain alkaloids prurieninine, prurienidine and five more alkaloids. (Rakhit, S. and Majumdar, D. N., 1956, *Indian J. Pharm.*, 18, 285).

Mundulea suberosa Benth.

A new compound which has been named 'munetone' has been isolated from the root bark of this plant in 0.3 per cent. yield. The substance has been found to be highly toxic to fish. (Dutta, N. L., 1956, *J. Ind. Chem. Soc.*, 33, 716).

Nardostachys jatamansi DC.

Active principle of *Nardostachys jatamansi*, a volatile oil was found to be less active than quinidine in the following tests : (i) refractory period of isolated rabbit auricles, (ii) experimental auricular flutter produced by injury-stimulation procedure in innervated and decentralized hearts of anaesthetized dogs, (iii) aconitine-induced and (iv) acetylcholine-induced auricular fibrillation in dogs. Also, it did not prove effective in digitalis-induced ventricular arrhythmias. When the effects of these drugs were compared on the electro-cardiogram of the cat, *Nardostachys jatamansi* was found to produce less prolongation of refractory period and less slowing of conduction than quinidine. The latter property is of distinct advantage over quinidine. In addition, the acute intravenous toxicity of *Nardostachys jatamansi* in mice was determined and found to be less than that of quinidine. The drug, therefore, promises to be of possible therapeutic usefulness and may be tried in cases of auricular flutter. (Arora, R. B. and Madan, B. R., 1956, *Ind. J. Med. Res.*, 44, 259).

Ocimum kilimandscharicum Guerke.

From the oil of the plant 78 per cent. camphor has been obtained. (Choudhury, J. K., 1954, *Sci. & Cult.*, 19, 354).

Oldenlandia biflora Roxb.

Work on biflorine and biflorone has shown that the two alkaloids are interconvertible. (Chauhan, R. N. S. and Tewari, J. D., 1954, *J. Ind. Chem. Soc.*, 31, 740).

Parmelia (Lichens)

Five different species of lichens belonging to *Parmeliaceae* family, viz. *P. cirrhata*, *P. soledica*, *P. manshurica*, *P. hyporysalae* and *P. sublaevigata*, available in India have been chemically examined. *P. cirrhata* contain atranorin, *d*-protolichesterinic acid and salzinic acid and the other four contain atranorin and lecanoric acid. (Aghoramurthy, K., Neelakantan, S. and Seshadri, T. R., 1954, *J. Sci. Industr. Res.*, 13B, 326).

Parmelia nimandairana Zahlbr.

Chemical examination of *Parmelia nimandairana* Zahlbr. of Indian origin has shown that it contains atranorin, lecanoric acid, gyrophoric acid and salazinic acid. (Rangaswami, S. and Subha Rao, V., 1954, *J. Sci. Industr. Res.*, 13B, 403).

Parmelia tinctorum Despr.

The lichen contains a lecanoric acid. (Rangaswami, S. and Subha Rao, V., 1955, *Indian J. Pharm.*, 17, 49).

Piscidia erythrina Linn.

A reinvestigation of the constituents of *P. erythrina* has led to the isolation of piscidic acid, rotenone and five apparently new aromatic substances. (Moore, J. A. and Stanley Eng, 1956, *J. Amer. Chem. Soc.*, 78, 395).

Pongamia glabra Vent.

Alcoholic extract of this plant causes appreciable mortality among house flies. (Mrs. Osmani, Z. H. and Naidu, M. B., 1956, *Sci. & Cult.*, 22, 235).

Ramalina farinaceae Ach.

The lichen contain usnic acid, sekikaic acid, nor-stictic acid. (Rangaswami, S. and Subha Rao, V., 1954, *Indian J. Pharm.*, 16, 197).

Rauvolfia beddomei Hook. f.

δ -Yohimbine and sarpagine have been isolated from the root of this plant. (Bose, S., Talapatra, S. K. and (Mrs.) Chatterjee, A., 1956, *J. Ind. Chem. Soc.*, 33, 379).

Rauvolfia canescens Linn.

A new alkaloid provisionally named raunescine, has been isolated from the roots and a 19-methyl- α -yohimbine or a 19-methyl-allo-yohimbine structure is suggested for it. Two new ester alkaloids have been isolated from this plant. Haemodynamic effects of Rauvolfia alkaloid causes in cats and rhesus monkeys marked fall of peripheral resistance through vasodilation without significantly altering the cardiac output. The effect is best obtained by intracisternal injection; higher doses give rise to an identical haemodynamic response after intraperitoneal injection though a much longer latency period is required. On intravenous injection, a fall of peripheral resistance is noted only after a transient period of cardiac irregularities and increased peripheral resistance. A predominantly central origin of the haemodynamic response is, therefore, indicated. (Bhattacharji, S., Dhar, M. M. and Dhar, M. L., 1956, *J. Sci. Industr. Res.*, 15B, 506; Hosansky, N. and Smith, E., 1955, *J. Amer. Pharm. Ass.*, 44, 639; Das, N. N., Dasgupta, S. R., Mukerjee, K. L. and Werner, C., 1955, *Ind. J. Med. Res.*, 43, 101).

Rauvolfia heterophylla Roem. and Schult.

A new alkaloid heterophyllin has been isolated from it. (Hochstein, F. A. and co-workers, 1955, *J. Amer. Chem. Soc.*, 77, 3551).

Rauvolfia natalensis Sond.

Reserpine and ajmaline have been isolated from this species. (Schuler, B. O. G. and Warren, F. L., 1956, *J. Chem. Soc.*, 215).

Rauvolfia serpentina Benth.

A new alkaloid isomeric with yohimbine and identified as 3-eip- α -yohimbine from this plant has been isolated. Degradative and synthetic evidence demonstrates the presence of the 3-epialloyohimbane ring system. Rescinnamine, a new alkaloid possesses pronounced hypotensive and sedative activity has been isolated. The total alkaloids in avian malaria (*P. gallinaceum*) has indicated the clinical inefficiency in this condition. (Bader, F. E., Dickel, D. F., Huebner, C. F., Lucas, R. A. and Schlittler, E., 1955, *J. Amer. Chem. Soc.*, 77, 3547; Klohs, M. W., Draper, M. D. and Keller, F., 1955, *J. Amer. Chem. Soc.*, 77, 2241; Rama Rao, R. and Sirsi, M., 1956, *Curr. Sci.*, 25, 357).

Schrebera swietenoides Roxb.

Gum Mokha from this plant on hydrolysis gave galactose, fructose and mannitol (70 per cent.). Almost 80 per cent. of mannitol present could be obtained in crystalline form. Chromatographic examination of the gum solution showed the presence of mannitol, fructose and a reducing sugar having a low R. value. It was found to be a disaccharide, probably a digalactoside, and named as swietenose. (Ingle, T. R. and Bhide, B. V., 1954, *J. Ind. Chem. Soc.*, 31, 943).

Senecio jacobaea Linn.

(See *Erechtites hieracifolia*, page 698).

Sisybrium loeselii Linn.

The chemical investigation of the fixed oil has shown the presence of saturated and unsaturated acids such as palmitic, stearic, arachidic, oleic, linoleic and linolenic. (Choudhari, S. S., Het Singh, and Handa, K. L., 1957, *J. Sci. Industr. Res.*, 16B, 45).

Tephrosia candida DC.

The seeds contain a crystalline substance identical with Hirta substance C isolated from the root bark of *Tephrosia hirta*. (Rangaswami, S. and Ram Sastry, B. V., 1956, *Indian J. Pharm.*, 18, 333).

Tephrosia hirta Ham.

The root bark contains three crystalline substances designated as Hirta substances A, B and C. (Rangaswami, S. and Ram Sastry, B. V. R., 1956, *Indian J. Pharm.*, 18, 43).

Tephrosia maxima Aers.

From its roots three crystalline substances have been isolated. (Rangaswami, S. and Ram Sastry, B. V. R., 1954, *Curr. Sci.*, 23, 397).

Tephrosia purpurea (Linn.) Pers.

The pods contain three crystalline compounds. (Subba Rao, N. V., 1956, *Curr. Sci.*, 25, 396).

Tephrosia vogelii Hook.

The seeds raised in the Nilgiris gave tephrosin and dehydrodeguelin in pure crystalline condition. (Rangaswami, S. and Ram Sastry, B. V. R., 1956, *Indian J. Pharm.*, 18, 339).

Toddalia aculeata Pers.

Toddaline the major constituent of the root bark of *Toddalia aculeata* is shown to be identical with chelerythrine, an alkaloid from the Papaveraceae family. (Govindachari, T. R. and Thyagarajan, B. S., 1956, *J. C S.*, 769).

Trichodesma incanum R.Br.

An optically inactive amino acid was present, which was identified as β -hydroxy-N-methyl-DL-norvaline A. (Adams, R. and Gianturco, M., 1956, *J. Amer. Chem. Soc.*, 78, 1919).

Tsuga heterophylla Sargent

The hemicellulose isolated from delignified Western Hemlock wood, by extraction with alkali, has been shown to contain a branched chain arabo-methoxy-glucurono-xylan. (Dutton, G. G. S. and Smith, F., 1956, *J. Amer. Chem. Soc.*, 78, 3744).

Veratrum viride Aiton

From commercial *Veratrum viride*, five hypotensive ester alkaloids, isogermidine, germbudine, neogermbudine, desacetylneprotoveratrine and veratetrine (neoprotoveratrine) have been isolated. (Myers, G. S. and co-workers, 1955, *J. Amer. Chem. Soc.*, 77, 3348).

Vernonia altissima Wild.

Isolation of *levo*-inositol, *meso*-inositol, and scyllitol from an aqueous extract of the air-dried leaves of *Vernonia altissima* has been reported. *Meso*-inositol was isolated from a basic lead acetate precipitate, and *levo*-inositol and scyllitol from the deionized filtrate by fractional crystallization. (Rowe, E. J. and co-workers, 1955, *J. Amer. Pharm. Asso.*, 44, 308).

Vinca minor Linn.

A crystalline alkaloid has been isolated. (Scheindlin, S. and Rubin, N., 1955, *J. Amer. Pharm. Ass.*, 44, 330).

Vitex peduncularis Wall.

Vitexin has been isolated from the root bark and leaves of *Vitex peduncularis*. (Rao, C. B. and Venkateswarlu, V., 1956, *Curr. Sci.*, 25, 328).

Wedelia calendulacea Less.

A new lactone, wedelolactone, has been isolated from it. (Govindachari, T. R., Nagarajan, K. and Rai, B. R., 1956, *J.C.S.*, 629).

Withania somnifera Dunal.

It contains alkaloids nicotine and six new alkaloids somniferine, somniferinine, somnine, withanine, withananine and withananinine. A pale yellow crystalline antibiotic substances has been isolated from the leaves of this plant. (Majumdar, D. N., 1955, *Indian J. Pharm.*, 17, 158 ; Kurup, P. A., 1956, *Curr. Sci.*, 25, 57).

INDEX OF COMMON VERNACULAR AND POPULAR NAMES

Aainuddik (Arab.)	260	Adityabhaktichettu (Tel.)	510
Aal (Bo.)	514, 605	Adivibankatige (Tel.)	320
Aanabahehindi (Arab.)	309	Adrak (H.)	255
Aane (Bo. & M.)	..	535	Adrakam (S.)	255
Aaraar (H.)	195	Adsoge (Guj.)	264
Aargis (Arab.)	289	Adu (Bo.)	255
Aarons rod (Eng.)	..	569	Adulaso (Bo. & H.)	264
Abba (Sing.)	666	Adulsa (Bo. & H.)	264
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Abroma bark (Eng.)	49	Advibadamu (Tel.)	414
Absinth (Eng.)	41	Aedu (M.)	537
Ach (H. & B.)	514, 605	Afim (H. & B.)	202, 205, 547
Aconite (Eng.)	16, 22, 40, 43, 49, 52, 60, 403		Afiun (Pers.)	202
Ada (B.)	255	Afiyum (H.)	202
Adadoda (Tam.)	264	African ginger (Eng.)	257
Adagam (Tam.)	284	Afsanthin (Arab. & Pers.)	71
Adalai (Tam.)	512	Afsantin (Arab.)	595
Adalsa (Bo. & H.)	264	Afsantin-ul-bahr (Arab.)	65
Adamas (Eng.)	531	Aftimoon (Pers.)	329
Adarsa (Bo. & H.)	264	Af-yun (Arab.)	204, 205
Adavi-amudan (Tel.)	665	Ag (H.)	305
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Adavi nabhi (Tel.)	675	Agara (Assam)	438
Adavipotla (Tel.)	688	Agaru (S., B. & Tel.)	495, 501, 595
Adaviyippa (Tel.)	356	Agasti (S.)	524
Addasaramu (Tel.)	264	Agatti (Tam.)	524
Adeps (Eng.)	533	Agetha (H.)	389
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Adhararuha (S.)	267	Aghedo (Guj.)	662
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Adibaricham (Tam.)	313	Agirunanandam (Tam.)	388
Adigam (Tam.)	336	Agise (Tel.)	524
Adigarradi (Tam.)	386	Agni (S.)	385, 386
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Adimaduram (Tam.)	183	Agnigarva (S.)	543
Adingam (Tam.)	261	Agnika (S.)	408
Adiphala (S.)	506	Agnimasha (S.)	313
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Agnishekharā (S.)	323	Akdamujhada (Guj.)	305
Agnishikha (S.)	323	Akhaul (H.)	270
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Agru (Tel.)	495	Akkini (Tam.)	386
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Aharbandhava (S.)	306	Akkirakaram (M.)	494
Aharmani (S.)	306	Akola (H.)	270
Aharpati (S.)	306	Akond (H.)	305
Ahibhuka (S.)	397	Akoria (H.)	560
Ahigandha (S.)	284	Akota (S.)	281
Ahilata (S.)	397	Akra (Vern.)	443
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Ailanto (Eng.)	555, 603	Akshadru (S.)	363
Aindavi (S.)	391	Aktemakat (Arab.)	388
Ain-ed-dik (Arab.)	261	Akujemudu (Tel.)	507, 673
Airan (Bo.)	501	Al (M.P., Bo. & Dec.)	514, 605
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Ajaballi (S.)	336	Alabaster (Eng.)	531
Ajadandi (S.)	597	Alagai (Tam.)	595
Ajaghandini (S.)	336	Alam (Mal.)	499, 596
Ajaka (S.)	516	Alangi (Tam.)	270
Ajakarna (S.)	602	Alarka (S. & Vern.)	306, 555, 601, 685
Ajamoda (S.)	495, 595	Alasi (Bo.)	512, 546, 677
Ajashrangi (S.)	336	Albumen (Eng.)	533
Ajava seeds (Eng.)	93	Ale (Mar.)	255
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	614	Alinnil (Mal.)	270
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Akado (Guj.)	305	Alkushi (B.)	559
Akan (H.)	305	Allam (Tam.)	255
Akanadi (B.)	320	Allamu (Tel.)	255
Akanda (B. & Mar.)	305	Alli (M.)	605
Akarakara (H., B. & Bo.)	494	Almond (Eng.)	40, 372, 614
Akara-karava (S.)	494	Aloes (Eng.)	19, 46, 49, 61, 62, 132, 454
Akarkanta (B.)	270	Alombe (Bo.)	655
Akarkara (Bo. & P.)	606	Alpam (Mal.)	301
Akasbel (H. & B.)	503, 578	Alpine (Sikkim)	57
Akasha (S.)	687	Alpine goat (Eng.)	465
Akashabel (Urdu)	329	Alshi (Tam.)	513, 598
Akashabela (H.)	329	Alshi-virai (Tam.)	677
Akashabhavana (S.)	329	Alshiviral (M.)	546
Akashavalli (S.)	578	Alsi (H.)	512, 598, 677
Akatti (Mal.)	524	Alstonia bark (Eng.)	49
Akauadi (H.)	320	Altwaallatu (Arab.)	340

Alu (Mar.)	.....	662	Amli (H., P. & Bo.)	.....	526, 686
Alui (Vern.)	.....	278	Amlika (S. & Tel.)	.....	526, 598, 605, 681, 686
Alum (Eng.)	.....	531	Amloki (H.)	.....	444
Alumen (Vern.)	.....	531	Amluki (Assam)	.....	673
Aluvigam (Tam.)	.....	267	Amra (S., H., B. & Bo.)	.....	513, 525, 601
Am (H., B. & Bo.)	.....	513, 598, 605	Amram (Mal.)	.....	513, 598
Ama (S. & Tam.)	.....	598, 605	Amramu (Tel.)	.....	513
Amada (B.)	.....	503	Amrataka (S.)	.....	525, 601
Amalaka (S. & Kan.)	264, 506	Amratakamu (Tel.)	525
Amalakamu (Tel.)	506	Amridavalli (Tam.)	427
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Amalu (P.)	689	Amritalata (S.)	427
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Amanakkam-chedi (Tam.)	236	Amritavalli (S.)	427
Amarabela (H.)	329	Amritphala (S.)	604
Amaravallari (S.)	.....	329	Amrud (H., P., Pers. & Arab.)	.....	521, 602, 683
Amaravela (S.)	.....	503	Amrul (H., B., Bo. & P.)	.....	598, 605, 681
Amarbeli (H.)	.....	578	Amrule (H.)	.....	599
Amari (Assam)	.....	527	Amrut (H. & I.)	.....	683
Amarlati (Assam)	329	Amruta (S.)	313
Amarvela (Mar.)	329	Amruta-phalam (S.)	683
Amaya (S.)	402	Amrytaburu (Tulu.)	427
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Ambahaldara (Guj.)	503	Amsania (P.)	144
Ambahindi (Pers.)	309	Amsul (Bo.)	674
Ambal (P. & Tam.)	288, 673, 679	Amudanda (P.)	291
Ambarbaris (Arab.)	.....	289, 292	Amuk (Nep.)	.....	683
Ambari (Bo.)	.....	510, 604	Amukkira (Tam.)	.....	437
Ambarvel (H. & Bo.)	.....	426, 518	Amukkiram (Mal.)	.....	436
Ambashtha (S.)	.....	320	Amuleh (Pers.)	.....	673
Ambashthika (S.)	.....	320	Amu-patchay-arissi (Tam.)	.....	335
Ambate (Kan.)	.....	525	An (Tam.)	.....	270
Ambavati (H.)	.....	599	Anagam (Tam.)	.....	401
Ambe-haldi (Bo.)	.....	671	Anaiteppili (Tam.)	.....	524
Amber (H., B., Bo. & M.)	.....	533	Anala (S.)	.....	386, 408
Ambergriis (Eng.)	.....	533	Analanama (S.)	.....	386
Amber-sugandah (S.)	.....	533	Ananas (Vern.)	.....	567
Ambervel (Mar.)	.....	427	Anandam (Tam.)	.....	274
Ambli (B.)	.....	526	Ananta (S.)	.....	187, 389
Ambrette seeds (Eng.)	.....	614	Anantamul (B.)	.....	187
Ambu (Tam.)	.....	288	Anar (P. & H.)	.....	522, 606
Ambuja (S.)	.....	598	Anara (Bo.)	.....	683
Ambu-prasadu (S.)	.....	686	Anaras (Vern.)	.....	567
Amelpodi (Bo.)	.....	397	Anar-ke-per (H.)	.....	522, 599
American wormseed (Eng.)	.....	50, 100	Anashuppu (M.)	.....	545
Amhaldi (H.)	.....	503	Anasphal (H.)	.....	545
Amil (P.)	.....	329, 503	Anbalah (Pers.)	.....	686
Amilam (Tam.)	.....	526	Anbli (H.)	.....	686
Amkudu (Tel.)	.....	342	Anboti-kura (Tel.)	.....	681
Amla (H., B., P., Bo., U.P. & Nepal)	.....	506, 598, 605, 673	'Anb-us-sa'lap (Arab.)	.....	685
Amlaj (Arab.)	.....	673	Anda (H.)	.....	536
Amlaki (B. & Uriya)	.....	506, 598, 673	Andakharbuja (H.)	.....	309
Amlam (Mal.)	.....	526			

Anedhera (H.)	270	Apamarga (S.)	493, 662
Aneshta (S.)	325	Apa-margamu (Tel.)	662
Anganapriya (S.)	401	Apang (B.)	493, 662
Angaravallari (S.)	261	Aparajit (H., B. & Bo.)	501, 544
Angaravalli (S.)	388	Aparajita (S.)	501, 544
Angkula (B.)	270	Apashoka (S.)	401
Angkura (B.)	270	Aphim (Bo.)	202
Angolavayiravan (Tam.)	270	Aphu (Bo.)	547
Angur (H., P. & B.)	530	Apina (S.)	312
Angurshefa (H. & P.)	72	Appagrass (Eng.)	613
Anguza (Afg.)	174	Appatta (Tam.)	320
Animal flesh (Eng.)	534	Appel (Malay)	683
Anisa (Guj.)	219	Appo (Bo.)	202
Anise (Eng.)	51, 96, 178, 219, 220, 614	Appracam (M.)	532
Aniseed (Eng.)	220, 221	Apya (S.)	402
Anjan (H., Bo. & Mar.)	421, 531	Arali (Vern.)	569
Anjana (S. & Mar.)	510, 532	Aralu (Mal.)	518
Anjani (H. & N.W.P.)	421	Aran (Mar.)	389
Anjara (Pers.)	296	Arana (Mal.)	311
Anjir (H. & B.)	508, 597	Arand (H. & P.)	236
Anjira (S.)	508, 597	Arandali (Tam.)	279
Anjra (Bo.)	508	Arandkharbuza (P.)	309
Anjuri (Pers.)	296	Arangakulitthika (S.)	311
Anjuru (Tel.)	508	Arani (Urdu)	389
Ankari (B.)	549	Araniketu (S.)	389
Ankoda (B.)	270	Araq badian (Vern.)	220
Ankol (Mar.)	270	Arar (H. & P.)	395
Ankola (S., Bo., Guj. & Urdu)	270	Arasa (Tam.)	674
Ankolaka (S.)	270	Arasi (Kan.)	527
Ankolam (Mal.)	270	Aratora (Dec.)	264
Ankolamu (Tel.)	270	Aratta (Mal.)	274
Ankoli (Guj. & Mar.)	270	Arattai (Tam.)	274
Ankolya (Guj.)	270	Araya (Tel.)	499
Ankora (H.)	270	Arayannali (Mal.)	279
Ankota (S.)	270	Ardanda (H.)	602
Ankotha (S.)	270	Ardrakamu (Tel.)	255
Ankotaka (S.)	270	Ardroka (Uriya)	255
Ankra (H.)	549	Ardubam (Tam.)	274
Ankudu kurra (Tel.)	689	Ardusi (Guj.)	264
Ankul (Mar.)	270	Areca-nut (Eng.)	64, 280, 282, 373, 374
Anna-bedi (Tam. & Tel.)	673	Ari (Mal.)	518
Anne-galu-gida (Kan.)	681	Ariavila (Mal.)	321
Anoda-gaha (Sing.)	661	Arikka (Tam.)	497
Antamora (B.)	340	Arimaedah (S.)	492
Antamul (H. & B.)	52, 230, 431, 689	Ari-matsya (S.)	534
Anthamul (Bo.)	431	Arippu (M.)	546
Antasatva (S.)	408	Arishi (Tam.)	518
Anti-dysenteric plants (Eng.)	594, 603	Arishta (S.)	360, 438
Anti-tubercular plants (Eng.)	600	Arishtha (S.)	271
Antomul (B.)	431, 689	Aritamunjayrie (S.)	661
Anupa (Vern.)	534	Arjan (H., P., Urdu & N.W.P.)	421
Anwlasar (P.)	686	Arjun (B., Bo. & Mar.)	421
Aonla (H.)	506	Arjuna (S., H., Mar. & Eng.)	421, 423, 546
Aoula (H.)	598, 605	Arjunasadra (Bo.)	421

Arjunladada (Mar.)	421	Ashvagandha (S.)	436
Ark (H.)	305	Ashvagha (S.)	425
Arka (S.)	306	Ashvaha (S.)	425
Arkabhakta (S.)	321	Ashvakandika (S.)	436
Arkakanta (S.)	321	Ashvakatri (S. & Mar.)	..	600, 602, 649	
Arkamu (Tel.)	306	Ashyamaraka (S.)	425
Arkamula (S.)	284	Ashvanashka (S.)	425
Arkhar (P.)	560	Ashvaroha (S.)	436
Arkhar (Bushahr)	526	Ashwagandha (H.)	52
Arkhol (P.)	523, 560	Ashyuka (S.)	514
Arkkam (Tam.)	306	Askandha (Mar.)	436
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Aromatic plants (Eng.)	..	616, 638, 641		Asolhamu (Tel.)	521
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Aru (H.)	547	Asphaltum (Eng.)	531
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Arusha (H. & Bo.)	264	Asula (U.P.)	673
Arushkara (S.)	408	Asundro (Bo.)	497, 603
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		175, 176		Asva (S.)	535
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Asan (H. & P.)	527	Asvagandhi (Tel.)	437
Asana (H.)	460	Asvattha (S.)	674
Asarun (H. & B.)	253	Aswamantaka (S.)	497, 603	
Asgandanagaori (Urdu)	437	Aswartham (Tam.)	674
Asgand nagori (P.)	436	Aswat (B.)	674
Asgund (Bo.)	436	Aswath (II.)	444
Ashadi-tal (Bo.)	684	Aswaththam (S.)	674
Ashathwa (B.)	674	Ata (B.)	577
Ash of mica (Eng.)	441	Ataicha (B.)	54
Ashok (Bo. & H.)	401	Atarusha (S.)	264
Ashoka (S. & Mar.)	401	Atarushamu (Tel.)	264
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Atika mamidi (Tel.)	297	Ayugmaparna (S.)	276
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Atimadhuramu (Tel.)	261	Ayurmader (Malay)	678
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Attei (M.)	536	Babrang (Pushtu)	672
Atti (Bo., Mal., Tam. & Tel.)	508, 674	Babri (H. & P.)	517, 672
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Attiradam (Tam.)	255	Babuitulsi (H. & B.)	517, 680
Atti-tippili (Tam.)	684	Babul (B., H. & P.)	492, 595, 661
Attittippali (Mal.)	524	Babuna (P.)	502
Attora (Sing.)	668	Babunah (Pers.)	664
Attumarudu (Tam.)	421	Babuni-ke-phul (H.)	664
Atulgan (P.)	367	Baburi (P.)	680
Atutintappala (Mal.)	664	Bach (H., B. & Assam)	262
Atwain (Fanti.)	353	Bacha (Urdu)	262
Audbhid (Vern.)	532	Bachita (Vern.)	570
Auk (Nep.)	306	Bachnab (Ind. Baz.)	60
Aura (H.)	673	Bachnag (H. & Ind. Baz.)	52, 60
Aurukesafur (Arab.)	325	Badala (H.)	538
Aushbahe-hindi (Pers.)	187	Badam (H., B., Bo., P. & M.)	521, 547
Avalguja (S.)	391	Badama (S.)	521
Avalkati (Bo.)	673	Badamu (Tel.)	521
Avalu (Tel.)	498	Badanala (B.)	559
Avam (Tam.)	358	Badar (Kash.)	660
Avara (Mal.)	596, 668	Badari (S.)	602
Avaram (Tam.)	596, 604	Badhaphala (S.)	388
Avari (Tam.)	668	Badian (Bo.)	545
Avartani (S.)	340	Badijuvvi (Tel.)	508
Avega (S.)	313	Badrang (H.)	602
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Avukaram (Mal.)	561	Baer (H.)	602
Awal (Guj.)	668	Baga-banosa (Bo.)	689
Awala (Cutch.)	668	Bagali-pakshina (Bo.)	533
Aya (Tam.)	511	Bag-berenda (H.)	676
Ayagam (Tam.)	336	Bagbherenda (B.)	676
Ayapana (Eng.)	51	Baghankura (B.)	270
Ayar (H.)	598	Baglatul-mulk (Arab.)	674
Ayil (Tam.)	312			

Bagua (H.)	548	Bal-nimb (Bo.)	360
Bahadra (Tel.)	688	Balra (Bo.)	687
Baheda (Mar.)	687	Balsam of Peru (Eng.)	268
Bahelshulli (Mal.)	353	Balsams (Eng.)	615
Bahera (H., B., P. & Mar.)	444, 527, 548, 687	Balsana (Urdu)	597
Baheri (B.)	687	Baluchi-koh-tor (Vern.)	546
Bahira (S. & P.)	527, 548, 687	Balukasag (H.)	597
Bahu (P.)	103	Bama (Bo.)	341
Bahudda (Bo.)	687	Bamanhati (B.)	521
Bahukanda (S.)	502	Bamber grass (Eng.)	613
Bahukantaka (S.)	430	Bamiya (Arab.)	676
Bahula (S.)	325	Bamiyah (Pers.)	676
Bahupallava (S.)	287	Bamunhati (B.)	500
Bahuparna (S.)	276	Ban (Arab.)	363
Bahuphali (Guj.)	502	Banada (P.)	599
Bahupushpa (S.)	358	Banafsha (B.)	98, 529, 689
Baibarang (Arab.)	367, 679	Banafshah (H. & Bo.)	529, 689
Baigun (H.)	602	Bana halak (Santh.)	681
Bail-ka-sofra (H.)	535	Banaphsa (Bo.)	689
Bak (B.)	524	Banar (S., H. & B.)	311, 536
Bakain (H. & P.)	363	Banbhnag (Kash.)	56
Bakarja (H.)	363	Banda (P.)	558
Bakas (B.)	264	Bandaru (P.)	367
Bakayan (Bo. & H.)	363, 364	Bandhuka (S.)	518
Bakayana (Urdu)	363	Bandhuli (B.)	518
Bakchi (H.)	434	Bandimurudu-du (Tel.)	667
Bakhra (P.)	430	Banga (S.)	443
Bakla (H.)	495, 595	Banga bhasma (H.)	443
Bakorcha (Garhwal)	683	Banger chhata (B.)	655
Bakra (H.)	545	Bangi-aku (Tel.)	87
Bakra-chimyaka (H.)	226	Bangla badam (B.)	599
Baksa (Mar.)	264	Banhalud (B.)	503, 671
Bakuchi (S.)	391	Baniari (B.)	521
Bakul (S., H. & B.)	514, 605, 614	Ban-kakri (P.)	226
Bakula (S.)	514	Bankau (H.)	512
Bakulam (Mal.)	514	Ban kela (P.)	675
Bala (S., B., Bo. & H.)	409, 460, 471, 605, 681	Banlaunga (H.)	605
Balabhadra (S.)	413	Ban mahuva (B.)	356
Balacharea (Bo.)	515, 679	Banna (P.)	689
Balada (S.)	436	Ban-ochra (Vern.)	570
Bala-hirade (Bo.)	688	Banokra (B. & H.)	438
Balaja (S.)	436	Banosa (B.)	689
Bala-phanijivika (H.)	409	Banpatol (B.)	688
Balarakkasi-gida (Kan.)	681	Banraj (B.)	497, 595
Bala-taila (H.)	410	Ban-ritha (B.)	492
Balbij (Cutch.)	661	Bans (H. & B.)	287, 578, 665
Balela (P.)	687	Bansa (H., Pers. & Dehra Dun)	264, 288
Bal-har (H.)	688	Bans kaban (H.)	505
Balhika (S.)	323	Bansolochana (S.)	665
Balimtra-polam (Tel.)	670	Bansuk (Nep.)	331
Balipriya (S.)	413	Ban-sulpha (B.)	674
Balkadu (Bo.)	181	Bantakalan (Arab.)	321
Ballaki (Bo.)	534	Bantulsi (Kumaon)	153
		Banwagan (Kash.)	226

Baphuli (H.)	502	Barola (B.)	558
Bar (B., H. & Pushtu)	508, 604, 673	Baroshialkanta (B.)	283
Bara-elachi (H. & B.)	144, 494	Barphali (H.)	173
Baragach (B.)	578	Barren ivy (Eng.)	558
Baragadamu (Tel.)	511	Barru (P.)	411
Baragokhru (H. & B.)	518, 681	Bartaku (S.)	602
Barahalkasa (B.)	512	Bartang (Bo., P. & Pers.)	379, 601
Barakhulanjan (Dec.)	274	Baru (H.)	548
Barahmi (H.)	341	Barun (H. & B.)	502, 600, 671
Barakalijan (B. & H.)	274	Bas (Bo.)	505
Bara-kanur (B.)	544	Basak (H. & Nep.)	331
Barakulanjan (B. & H.)	274	Basant (H. & P.)	597
Baraloniya (B.)	521	Bashangarus (Kumaon)	264
Barambhi (H.)	341	Bashika (S.)	264
Baran (P.)	687	Bashing (H.)	264
Baranebu (B.)	130	Bashkhira (Urdu)	297
Baranibu (H.)	130	Basil (Eng.)	613
Barasinga (H.)	535	Basing (Bo.)	600, 602
Barbados lilac (Eng.)	363	Basinga (Kumaon)	264
Barbara (S.)	321	Basl (Arab.)	602
Barbatti (Bo.)	600	Basna (H. & Bo.)	524
Bargad (P.)	673	Bassant (H. & P.)	545, 558
Bargat (H.)	673	Bastard (Eng.)	230
Bargetanbol (Pers.)	371	Bastard dittany (Eng.)	556
Barghat (Bo.)	673	Bastard oleander (Eng.)	425
Barhang (Pers.)	379	Bastishodhana (S.)	395
Barhanta (H.)	527, 548	Bastitaj (Arab.)	430
Barhi (S.)	386	Bastra (H.)	596
Barhmi (Urdu)	352	Bat (B.)	673
Bari (P.)	689	Batabi limbu (Vern.)	624
Bariar (H.)	409	Batbor (P.)	674
Barihoj (P.)	262	Baterpakhi (B.)	538
Barik-til (Bo.)	684	Bathua (P.)	669
Bari-main (B. & H.)	687	Bathur (Bo.)	687
Barilibiyam (Tel.)	511	Bathu-sag (H. & B.)	660
Barilla (Eng.)	531	Batindu (P.)	427
Bari-mahin (P.)	687	Batu (Arab.)	671
Baring (Arab.)	367	Batyalaka (S.)	409
Barinika (Tel.)	526	Baulo (Uriya)	678
Baripankijar (Bo. & Dec.)	274	Bavacha (Guj.)	391
Bari-pipli (H.)	684	Bavachi (B.)	391
Bari saunf (H.)	176	Bavachya (Mar.)	391
Bari-sopha (Bo.)	176	Baval (Guj.)	661
Bark (Kash.)	427	Bavanchi (H.)	391
Barkhanghi (H. & B.)	595	Bavanji (Tel.)	313
Barkista (Arab.)	336	Bawachi (Bo.)	391
Barkulilahara (Nep.)	412	Bawang (Mal.)	662
Barliyarisi (Tam.)	511	Baxsingh (Mar.)	649
Barma (P.)	687	Bayabirang (H.)	600
Barmat (Kumaon)	424	Bayrah (P.)	687
Barmi (Bo. & Guj.)	351, 526, 687	Bazinali (B.)	602
Barna (P. & H.)	502, 671	Bazrekatima (Arab.)	379
Barnagi (H.)	600	Bazrequatuna (Arab.)	379
Baro-kheruie (B.)	507	Bead tree (Eng.)	363

Beamī (Mal. & Tam.)	.....	341	Bhadra (S.)	....	262, 397
Bebrang (P.)	.....	367, 679	Bhadrabala (S.)	....	501
Bechadi (Kan.)	....	597	Bhaibirrung (B.)	....	672
Beda (Mar.)	....	687	Bhairah (B.)	....	687
Bedana (Pers.)	....	292	Bhais (H.)	..	534
Bedanjire-khatai (Pers.)	..	665	Bhaira (H.)	....	687
Bede-mushk (Pers.)	..	684	Bhakhra (P.)	..	528
Bedmushk (H. & P.)	..	684	Bhakra (P.)	....	528
Bedoli sutta (Assam)	...	681	Bhakri (H. & Bo.)	..	537
Bedun (Bo.)	....	536	Bhakshataka (S.)	..	430
Beerbough tee (H.)	..	535	Bhakshyapatra (S.)	..	371
Baghnoki (B.)	....	601	Bhali (S.)	..	386
Behada (Bo.)	....	687	Bhallataka (S.)	..	408
Behara (Bo.)	.....	527, 548, 687	Bhambelis (Jaunsar)	....	173
Behasa (Bo.)	..	687	Bhandaka (Sing.)	..	676
Behda (Bo.)	....	687	Bhandira (S. & Mar.)	..	670
Behedan (Bo.)	....	687	Bhang (B. & H.)	84, 85, 86, 89, 90, 91	
Behra (H.)	....	687	Bhanga (S.)	..	84, 85
Behurbans (B.)	..	287	Bhangan (B.)	....	536
Bekhgillo (Kash)	..	427	Bhangaruda (Mar.)	....	498, 595
Bekh-i-banfsa (Pers.)	....	676	Bhangi (Kan. & Tam.)	...	84
Bekh sosan (Kash.)	....	676	Bhangra (H., B. & Bo.)	505, 597, 599, 672	
Bel (B., Mar., Urdu, Assam & Kumaon)	.....	267, 512	Bhant (H. & B.)	....	322
Bela (B. & Bo.)	....	267	Bhaphali (Ind. Baz.)	....	596
Beladin (Arab.)	..	407	Bharamdandi (Dec.)	....	283
Belatak (H.)	....	407	Bharangi (S., H., Bo. & Tel.)	500, 521, 600	
Belatijau (B.)	....	604	Bharbari (Santh.)	..	680
Belkangu (Dehra Dun)	....	500	Bharbhand (H.)	..	283
Belladonna (Eng.)	11, 31, 35, 36, 40, 49, 72, 73, 74, 76, 77, 91, 135, 266, 406		Bharbhurwa (N.W.P.)	..	283
Bellary-leaf (Eng.)	....	613	Bhargi (S.)	..	500
Belparash (Pers.)	....	329	Bharla (H.)	..	687
Beltivas (Mar.)	....	303	Bhaskar (S.)	..	306
Benduruppu (Tel.)	....	358	Bhasmas of abhra, banga, lauha, raupya & swarna (S.)	441, 443, 445, 454, 461	
Bengal quince (Eng.)	....	267	Bhasura (S.)	..	402
Bentha (Kash.)	....	195	Bhat (Bo.)	....	322
Bera (P.)	....	673	Bhatkateya (P.)	....	283
Berain (Kumaon)	....	561	Bhatmil (P.)	....	283
Berberis root (Eng.)	....	49	Bhatta (Bo.)	....	518
Berela (B.)	....	409, 471	Bhauma (S.)	....	297
Bergamot (Eng.)	....	614	Bhavan-bakra (H.)	....	226
Bet (H., B. & Bo.)	....	603	Bhavanj (H.)	..	391
Betain (H.)	....	363	Bhedani (S.)	....	502
Betan (Mal.)	....	667	Bhedi janetct (Santh.)	....	664
Betel (Eng.)	51, 373, 375, 376, 377		Bheka (S.)	..	537
Betel leaf (Eng.)	371, 372, 374, 614		Bhekaparni (S.)	....	352
Betel nut (Eng.)	49, 282, 372, 376		Bhekar (P.)	....	264
Betel nut palm (Eng.)	....	280	Bheki (S.)	....	352
Betel nut tree (Eng.)	....	280	Bhekkar (Jhelum)	....	264
Betel oil (Eng.)	....	373	Bhela (B., H. & P.)	....	407, 408
Betel popper (Eng.)	....	371	Bhelatuki (B.)	....	407
Bethu sager (H. & B.)	....	102	Bhenda (Bo.)	....	676
Bezoar (Eng.)	....	534	Bhendi (H., Bo., Tam. & M.P.)	676, 688	

Bhendu (H. & N.W.P.)	340	Bhulavaanga (S.)	605
Bhera (B.)	537	Bhumari (S.)	98
Bherband (P.)	283	Bhumibala (S.)	409
Bherda (Mar.)	687	Bhumi-jambu (S.)	606
Bherdha (Bo.)	687	Bhumikashmanda (S.)	676
Bherenda (B.)	236	Bhumikumra (B.)	511
Bhernda (H.)	676	Bhumikushmanda (S.)	511
Bhersing (Vern.)	568	Bhumjambu (S.)	521
Bheyra (H.)	407	Bhumyamalaki (S.)	519, 605
Bhiba (Bo.)	407	Bhunguru (Kumaon)	685
Bhikshu (S.)	353	Bhunimba (S.)	250, 278, 603
Bhilabhushana (S.)	261	Bhupadma (S.)	98
Bhiladar (P.)	408	Bhuringni (Bo.)	525, 686
Bhilama (Bo.)	407	Bhurjapatra (S. & B.)	595
Bhilamu (Guj.)	407	Bhustrina (S.)	503, 672
Bhilanvana (Urdu)	408	Bhutabhna (S.)	271
Bhilawa (H. & P.)	407, 408	Bhutakesi (S.)	596
Bhilawan shell (H.)	110	Bhutali (Kan.)	525
Bhillataru (S.)	413	Bhutanashana (S.)	408
Bhilli (S.)	413	Bhutan kusamu (M.)	578
Bhimb (Bo. & H.)	314	Bhuta-pala (Bo.)	545
Bhindi (H. & P.)	597, 676	Bhutbhiravi (B.)	389
Bhindu (Guj.)	676	Bhutigatt (Kash.)	515
Bhirand (Bo.)	674	Bhutika (S.)	504
Bhirandel (Bo.)	674	Bhut kesi (H. & B.)	596
Bhiranga (B.)	672	Bhu-tulasi (Tel.)	517, 680
Bhiringaraja (S.)	505	Biba (Bo.)	407
Bhirmie (B.)	526, 687	Bibha (Mar.)	408
Bhishakapriya (S.)	427	Bibla (Bo.)	522, 599
Bhishangmata (S.)	264	Bibu (Bo. & Mar.)	408, 558
Bhokani (S.)	536	Bibwa (Mar.)	408
Bhomroti (Assam)	413	Bichati (B.)	527
Bhonpatri (Mar. & Guj.)	512	Bichhu (Kumaon)	561
Bhooyanankeri (Konkani)	339	Bichtarak (B.)	495
Bhor (P.)	674	Bichu (H., B. & P.)	561, 601
Bhoree loth (H.)	670	Bichua (H. & P.)	561
Bhringaraja (S.)	597	Bichuti (B.)	548
Bhringeshtha (S.)	523	Bifay (Vern.)	647
Bhui-amla (B.)	519, 598	Bigasar (H.)	599
Bhui-avala (Bo.)	519	Bighbarindeh (Pers.)	386
Bhuiavali (Bo.)	598	Bihi (H.)	604
Bhuidari (Bo.)	549	Bijapadapa (S.)	408
Bhui-dumur (B.)	604	Bijapura (Kan.)	130
Bhuikanda (Bo.)	251	Bijapuram (Tel.)	130
Bhui-kohala (Bo.)	511, 676	Bijasar (H.)	522
Bhuikumra (B.)	676	Bijband (Vern.)	409
Bhui mug (Mar.)	63	Bijori (Kan.)	130
Bhui-tulsi (B.)	684	Bikh (B.)	57
Bhujangakshi (S.)	397	Bikh-i-banafshah (Pers.)	676
Bhujangalata (S.)	371	Bikhma (Vern.)	53
Bhujangavalli (S.)	371	Bil (Guj.)	267
Bhujpattrra (H.)	595	Bila (Bo.)	267
Bhukuri (P.)	430	Biladhutura (H.)	283
Bhulagna (S.)	438	Biladur (Pers.)	408

Bilaikand (H. & Bo.)	511, 676	Bockada (Tel.)	670
Bilambi (Bo.)	407	Bodasoram (Tel.)	525
Bilati badam (B.)	521	Bodda (Tel.)	674
Bilawa (P.)	408	Bode grass (Eng.)	613
Bildi (P.)	194	Bodha (S. & Bo.)	270, 667
Bili (H.)	267	Bodhaniya (S.)	262
Bililotan (H.)	601	Bohar (P.)	673
Billy (Guj.)	267	Bohera (B.)	687
Bilnalita (B.)	596, 604	Bokenal (Bo.)	559
Biloja (P.)	561	Bol (H. & Pers.)	670
Bilva (S.)	267	Bola (Kan.)	670
Bilvamu (Tel.)	267	Bolam (Sing.)	670
Bilwuli (Mar.)	558	Boli (H.)	501
Bimba (S.)	314, 596	Bolidda (Mal.)	511
Bimbal (Mar.)	672	Bolsari (Guj.)	678
Bimbis (Mar.)	314	Bomajemudu (Tel.)	507
Bimbu (B.)	314	Bonbheranda (B.)	676
Bincha (B.)	602	Bond-na-cha (B.)	536
Bindimuthi (Santh.)	604	Bondue nut (Eng.)	304
Bipte (Mar.)	558	Bondumalle (Tel.)	512
Birakaya (Tel.)	354, 677	Bonga (Tel.)	665
Biranga (B.)	506	Bongu (Tel.)	288
Biranjaisif (Cutch.)	601	Bonguveduru (Tel.)	288
Bird's eye (Eng.)	555	Bonjoi (B.)	500
Birha (P.)	687	Bonkloye (Burm.)	661
Birhatta (H.)	524	Bonmethi (B.)	409, 606
Birmi (H., P. & Kash.)	526, 687	Bonpatol (B.)	549
Birmova (Bo.)	604	Boppayi (Tel.)	309
Bis (P.)	606	Bor (H. & P.)	508, 604, 673
Bish (H. & Arab.)	54, 56, 57	Bori (Malay)	671
Bisha (B.)	52, 675	Borsali (Bo.)	514, 605, 678
Bishalanguli (B.)	509, 675	Boruna (B.)	435
Bishkapra (Bo., P. & Vern.)	548, 570	Botha grass (Vern.)	613
Bishlanguli (B.)	579	Bottuka (C.P.)	340
Bishnag (Pers.)	54	Box-wood (Eng.)	544
Bishop's weed (Eng.)	93	Boyra (B.)	687
Bislambhi (H.)	545	Bracken fern (Eng.)	651
Bislanhi (Vern.)	567	Brahmadandi (S. & Tel.)	283
Bismar (Saharanpur)	270	Brahmadundi (H.)	283
Bisru (P.)	312	Brahmamanduki (H. & B.)	668
Black cummin (Eng.)	569	Brahma manduki (S., H. & B.)	351, 352
Black dhatura (Eng.)	88	Brahmandanti (Mal.)	283
Black mint (Eng.)	198	Brahmi (S., H. & Mar.)	283, 341, 352
Black oil tree (Eng.)	313	Bramadandu (Tam.)	283
Black spleen wort (Eng.)	648	Bramhadandi (S., H. & Bo.)	597, 599
Blinding tree (Eng.)	557, 568	Branchu (P.)	367
Blaksha (P. & B.)	545	Brank (Eng.)	557
Blue gum-tree (Eng.)	167	Brela (B.)	409
Blue pine (Eng.)	223	Brihadaela (S.)	494
Blue vitriol (Eng.)	531	Brihannimba (S.)	363
Blumichcham-tulasi (M.)	580	Brihatphala (S.)	497
Bnah (Assam)	287, 665	Brihattikta (S.)	320
Bobbi (Mar.)	596	Brihattrina (S.)	287
Bobunaj (Arab.)	664	Brihattvaka (S.)	276

Brihmi-sak (B.)	341	Canadian maiden hair (Eng.)	648
Brimposh (Kash.)	605	Cannalavangapattai (Tam.)	126
Brown mustard (Eng.)	49	Caraway (Eng.)	50, 92, 93, 96, 298, 614
Brown sarsaparilla (Eng.)	187	Cardamom (Eng.)	142, 143, 144, 165, 403, 614
Buchanaka (S.)	63	Cardamom fruit (Eng.)	51
Buckwheat (Eng.)	542, 557	Carilla fruit (Eng.)	568
Budagur (P.)	146	Carrot (Eng.)	556
Budbar (B.)	506, 600	Cascara (Eng.)	10, 174
Budha-kakara (Tel.)	667	Cashew (Eng.)	41
Budida-gummadi (Tel.)	497	Cashew apple (Eng.)	555
Bue (Vern.)	376	Cashew nut (Eng.)	555
Buffalo (Eng.)	534	Cashoo nut tree (Eng.)	280
Bugra (P.)	321	Cassarva (Ind. Baz.)	547
Buhura (H.)	687	Cassava (Eng.)	547
Buhuru (B.)	687	Cassia (Eng.)	613, 618
Buin (P. & Kash.)	598, 605	Cassia fruit (Eng.)	50
Bukam (Mal.)	305	Cassina (Eng.)	83
Bukchi (H.)	391	Cassiterite (Eng.)	443
Bukslat-ul-mulik (Arab.)	674	Cast iron (Eng.)	446
Bundak (Arab.)	603	Castoreum (Eng.)	534
Bunk (Eng.)	318	Castor seeds (Eng.)	41, 236, 237
Bunokra (B.)	606	Catechu palm (Eng.)	280
Bur (Bo.)	673	Catechu tree (Eng.)	280
Bura keru (B.)	335	Cat's milk (Eng.)	556
Burkai (Tel.)	354, 513, 677	Cattibira (M.)	546
Burmie (B.)	687	Cedar (Eng.)	311, 613
Burrangokhur (H.)	430	Cephalopoda (Eng.)	535
Burundi (Bo.)	510, 545	Cerikkotta (Mal.)	408
Bur-weed (Eng.)	438	Cetaceum (Eng.)	535
Bushita (S.)	270	Ceylon Cinnamon (Eng.)	126
Busteyrumi (Arab.)	430	Ceylon leadwort (Eng.)	386
Butea seed (Eng.)	50	Cha (H., B. & Mar.)	79
Butshubr (P.)	146	Chab (H.)	520, 601
Butshur (P.)	144	Chaburanja (H.)	537
Buttercups (Eng.)	41	Chachar (P.)	292
Butter tree (Eng.)	356	Chachi bet (H., B. & Bo.)	596
Byakura (B.)	524	Chachinga (H.)	528
Byang (B.)	537	Chachri (P.)	367
Cajuput (Eng.)	613	Chachu (S.)	296
Cajuputa (Mar.)	678	Chadurakalli (Mal.)	507
Cajuputi (Malay)	678	Chadu til (B.)	684
Cajuputte (B.)	598, 678	Chae-kashmiri (Pers.)	672
Calicut ginger (Eng.)	258	Chagulbanti (B.)	330, 598
Californian cinchona (Eng.)	413	Chai (H., B. & Mar.)	79
Calthrops (Eng.)	430	Chaitra (Kesh.)	424
Calumba (Eng.)	32, 293, 294	Chakanda (H. & B.)	596
Calumba wood (Eng.)	293	Chakki (Vern.)	88
Camel (Eng.)	534	Chakor (B.)	533
Camel grass (Eng.)	613	Chakotra (B. & H.)	506
Camphor basil (Eng.)	123	Chakra (S.)	377
Camphor tree (Eng.)	120	Chakralakshana (S.)	427
Cannabis (Eng.)	50, 88, 91	Chakramarda (S.)	499, 600
Canada fleaband (Eng.)	556	Chakrangi (S.)	377, 427

Chakrani (S. & Mar.)	.....	301	Charas (H. & B.)	84, 85, 86, 88, 89, 90, 104
Chakrashalay (S.)	.....	261	Charayatah (H.)	.....
Chaksi (H.)	.....	311	Charayetah (H. & Dec.)	.....
Chaksie (Bo.)	.....	311	Charbee (B.)	.....
Chaksu (H. & Urdu)	.....	311	Char-bughra (Vern.)	.....
Chakulia (B.)	.....	529	Charoli (Mar. & Guj.)	.....
Chakunda (H. & B.)	.....	499, 600	Charu (S.)	.....
Chakut (H.)	.....	311	Charvarmada (Mar. & Bo.)	.....
Chakwit (Bo.)	.....	609	Chashmekhauush (Pers.)	.....
Chalavamiriyalu (Tel.)	.....	224	Chashmizaj (Arab.)	.....
Chalkumra (B. & P.)	.....	497	Chashmizak (Pers.)	.....
Challa gaddalu (Tel.)	.....	665	Chashum (Pers.)	.....
Challamulaga (Tel.)	.....	525	Chasmkuros (Pers.)	.....
Chamargular (C.P.)	.....	358	Chaste (Eng.)	.....
Chamari (Mar.)	.....	389, 683	Chataki (B.)	.....
Chamba (H. & Kash.)	.....	511, 633	Chataka (S.)	.....
Chambalika (H.)	.....	616	Chataki (S.)	.....
Chambeli (S., Bo. & H.)	.....	512, 597	Chata-rashi (Tel.)	.....
Chameli (B.)	.....	512, 597, 633	Chatian (Assam)	.....
Chamlani (Nep.)	.....	413	Chatium (B., H. & Kumaon)	.....
Champa (Bo., H., B. & Vern.)	.....	514, 569	Chatiwan (Nep.)	.....
Champabaha (Santhi.)	.....	601	Chatraparna (S.)	.....
Champaca-flower (Eng.)	.....	613	Chatri (Nep.)	.....
Champaka (S., H. & B.)	.....	514	Chattankaya (Mal.)	.....
Champakam (Mal.)	.....	514	Chattu-clupa (Tam.)	.....
Champakmu (Tel.)	.....	514	Chatung (Kash.)	.....
Chana (H. & Bo.)	.....	596	Chatwan (B.)	.....
Chanadruma (S.)	.....	430	Chaulmogra (H., B. & Bo.)	.....
Chanda (S.)	.....	438	Chaulmoogra (Eng.)	51, 414, 418
Chandana (S.)	.....	323	Chaulmoogri (Arab.)	.....
Chandan betu (H. & B.)	.....	102, 669	Chaupatia (H.)	.....
Chandata (S.)	.....	425	Chavaka (Guj.)	.....
Chanderlekha (S.)	.....	391	Chaval (H. & B.)	.....
Chanderprabha (S.)	.....	391	Chavika (S.)	.....
Chandkuda (Mar. & Bo.)	.....	279	Chchinna (S.)	.....
Chandkura (Mar.)	.....	279	Chchinnaruha (S.)	.....
Chandla (Bo. & Mar.)	.....	279	Chchinnodhana (S.)	.....
Chandna (P.)	.....	677	Chchinnodbava (S.)	.....
Chandra (S., Bo. & B.)	.....	358, 397	Chebira (Tel.)	.....
Chandrasah (S.)	.....	427	Chedukodise (Tel.)	.....
Chandrapasa (S.)	.....	427	Chein (P.)	.....
Chandra shura (S.)	.....	598	Chcka-parni (S.)	.....
Chandraspada (S.)	.....	377	Chelonia (Eng.)	.....
Chandrasura (S.)	.....	397	Chem (Mal.)	.....
Chandrika (S.)	.....	397	Chempalukka (Mal.)	.....
Chandul (Bo.)	.....	279	Chemparutti (Mal.)	.....
Chang shan (Chinese)	.....	331	Chemudu (Tel.)	.....
Chanjanbutai (Baluchi)	.....	598	Chena (Mal.)	.....
Chanoti (Guj. & Mar.)	.....	260	Chendiramu (Tel.)	.....
Chanu (B.)	.....	495, 595	Chengeri tenga (Assam)	.....
Chapra (H.)	.....	679	Chenkolli (Mal.)	.....
Charachi (Tel.)	.....	509	Chenopodium (Eng.)	101 102, 639, 669
Charaigorwa (H.)	.....	435	Chepa-nune (Tel.)	.....
Charai pakhi (B.)	.....	537	Chera (Mal.)	.....

Cherailu (H.)	601	Chingati (S.)	537
Cheraken (Java)	671	Chingri (B.)	537
Cheraku (Tel.)	523	Chinna-kata banda (Tel.)	61
Cherivallal (Mal.)	597	Chinni (Tel. & Dec.)	492
Cherikkuru (Mal.)	408	Chintapandu (Tel.)	686
Cheruchanavittintivilta (Mal.)	513	Chipita (S.)	311
Cherupinnai (Mal.)	596	Chipkuli (H.)	537
Cherupoyara (Mal.)	519	Chippa bhasma (B.)	534
Cheshmak (Pers.)	311	Chippa-gaddi (Tel.)	672
Cheti-potla (Tel.)	688	Chir (H. & P.)	221, 520, 598
Chettikotuvveli (Mal.)	385	Chirabilva (S.)	388, 511
Chettu (Tel.)	686	Chiraita (Bo.)	250
Chewa (P.)	144, 146	Chiratta (H.)	250
Chhagal-bati (B.)	681	Chirbhita (S.)	309
Chhagriaruba (H.)	435	Chireta (P. & B.)	250, 322, 424
Chhataphala (S.)	281	Chiretta (Eng.)	52, 250
Chhatim (B.)	276	Chirghas (Kash.)	545
Chhatrak (S.)	655	Chiribenda (Tel.)	409
Chhatraka (S.)	353	Chirimanu (Tel.)	495
Chhipa (Bo.)	534	Chir pine (Eng.)	123, 221, 223
Chhotachand (H., Bo. & B.)	397	Chironji (H. & B.)	498
Chhotadudhilata (H.)	336	Chiror (P.)	291
Chhotagokhru (H.)	430, 438	Chirpoti (H.)	549
Chhota kulpha (H.)	528	Chirru (P.)	438
Chhoti dudhi (H.)	579	Chirukattali (Tam.)	61
Chian (H.)	334	Chirukizhukanelli (Mal.)	519
Chiatarui (H.)	546	Chirupalleru (Tel.)	430
Chibhado (Sind.)	309	Chirval (H.)	601
Chichinda (S. & P.)	528	Chita (H. & B.)	386
Chichinga (B.)	528	Chitabansa (P.)	194
Chichm (Arab.)	311	Chitalakri (Urdu)	386
Chichra (H.)	301	Chitarak (H., C.P. & P.)	385, 386
Chickana (Bo.)	677	Chitawar (H.)	386
Chicory (Eng.)	318, 319	Chiti (H.)	386
Chikana (Mar.)	409	Chitisirin (P.)	312
Chikinamu (Tel.)	281	Chitruk (B.)	386
Chikini (Tel.)	281	Chittigara (Tel.)	508
Chikkana (S.)	281	Chittimulaga (Tel.)	524
Chiknimati (H.)	531	Chitu (Nep.)	386
Chikri (Kash.)	544	Chitra (S., H., B., Bo., Pers., P., Nep. & N.W.P.)	289, 290, 385, 386, 401, 545
Chikti (H.)	606	Chitrack (Bo.)	386
Chikunda (Mar.)	493	Chitraka (S. & Mar.)	385, 386
Chil (H.)	221	Chitramul (P.)	424
Chilauni (H.)	561	Chitramula (Mar.)	386
Chili ragha (Garhwal)	660	Chitramulamu (Tel.)	386
Chillies (Eng.)	667	Chitranga (S.)	386
Chillu (Tam.)	334	Chitravalli (S.)	386
China-alla (Sing.)	685	Chitrayodhi (S.)	421
China-badam (B.)	63	Chitu (Nep.)	670
China clay (Eng.)	532	Chobachini (S.)	685
Chinai katha (Bo.)	689	Chobchini (S., H., B., Bo. & P.)	524, 685
Chinakarab (B.)	425	Chodhari (Bo.)	669
China nora (Eng.)	413	Choi (B.)	520
Chinduga (Tel.)	493		

Chola (B. & P.)	596	Cocaine plants (Eng.)	161
Cholam (M.)	548	Cochineal insect (Eng.)	535
Chopra (Simla)	173	Cochin ginger (Eng.)	257
Choriyanam (Mal.)	527	Cochin grass (Eng.)	613
Chosi (Nep.)	560	Cochinil puchi (M.)	535
Chotagokhru (H.)	528, 599	Cocklebur (Eng.)	438
Chota-kirayata (H.)	673	Cocoa (Eng.)	83, 203, 268
Choti dudhi (H.)	507	Coconut (Eng.)	50, 127
Choti elachi (H. & B.)	142	Coffee (Eng.)	79, 80, 81, 83, 203
Choto kulpa (B.)	528	Coffee plant (Eng.)	50
Chotokut (B.)	599	Coke (Eng.)	30
Chotra (H.)	289	Colchicum corm and seed (Eng.)	50
Chua (H.)	536	Colocynth (Eng.)	50, 129
Chucka (H.)	578	Colombian bark (Eng.)	115
Chudala (S.)	261	Colombo (Bo.)	605
Chudamani (S.)	261	Columbo wood (Eng.)	293
Chuka (H., B. & Bo.)	599, 606	Common emetic nut (Eng.)	395
Chukapalam (B.)	547, 560	Common marking nut (Eng.)	407
Chukha (P.)	681	Common nettle (Eng.)	561
Chukra (S.)	599, 606	Common rue (Eng.)	560
Chukrika (S.)	681	Conch (Eng.)	538
Chumlani (Nep.)	411	Conessi bark (Eng.)	342, 343
Chun (B.)	666	Copaiba (Eng.)	220, 243, 286, 287, 614
Chuna (H.)	666	Copra (Eng.)	127
Chunah (P.)	666	Coral (Eng.)	535
Chunambu (Tam.)	666	Coriander (Eng.)	50, 614
Chundrus (B.)	689	Costa Rica sarsaparilla (Eng.)	187
Chunhati (B.)	260	Costus (Eng.)	402
Chuno (Guj.)	666	Cotton plant (Eng.)	568
Chupra (U.P. & N.W.P.)	367, 679	Country mallow (Eng.)	409
Chur-ganja (H.)	88	Country-man's treacle (Eng.)	560
Churls' treacle (Eng.)	271	Cowhage (Eng.)	559
Churna (S.)	666	Cowrie (H.)	535
Chutrika (S.)	547, 560	Cowry (Eng.)	535
Chutro (Nep.)	289	Cow's urine (Eng.)	538
Chuvannakotuveli (Mal.)	385	Crab (Eng.)	538
Chuvannailpuri (Mal.)	397	Crab's claw (Eng.)	560
Cinchona (Eng.)	31, 32, 34, 41, 50, 114, 116, 120, 138, 369, 429, 436,	Creat (Eng.)	278
Cinchona bark (Eng.)	20, 29, 111	Creeping ivy (Eng.)	558
Cinnamon (Eng.)	50, 165, 302, 613	Cress (Eng.)	568
Cinnamon oil (Eng.)	623	Crown bark (Eng.)	112
Citron (Eng.)	614	Cubebs (Eng.)	51, 221, 224, 243, 261, 286, 614
Citronella (Eng.)	613	Cuckoo (Eng.)	535
Citronella grass (Eng.)	94, 200, 630, 631	Cumin (Eng.)	93, 95, 96, 614, 615
Citteggi (Tel.)	504	Cumin water (Eng.)	94
Civet cat (Eng.)	538	Cundung katric (Tam.)	686
Clay (Eng.)	531	Cuprea bark (Eng.)	115
Climbing staff plant (Eng.)	313	Curcuma (Eng.)	327
Clother (Eng.)	438	Cutch (Pers.)	292
Clove (Eng.)	51, 127, 172, 173, 613, 635	Cuttle fish (Eng.)	537
Cobbler's pegs (Eng.)	556	Cwitch (Eng.)	559
Cobra venom (Eng.)	476		
Coca (Eng.)	32, 161, 162, 163, 166	Dabali (Guj.)	661
		Daboia venom (Eng.)	476

Dabur (B.)	.....	316	Darimba (S.)	.....	599, 606
Dadamardana (Mar.)	.....	668	Darshishaan (Pers.)	.....	678
Dadamari (S.)	.....	499	Daru (P.)	.....	683
Dadhuri (P.)	.....	674	Darudi (Guj.)	.....	283
Dadima (S.)	.....	522, 683	Daruhaldar (Guj.)	.....	290
Dadiman (Mal.)	.....	522	Daruahaldi (H. & Mar.)	.....	290
Dadmari (B.)	.....	596, 668	Daruharidra (S. & B.)	.....	289, 290, 293
Dadmurdan (H.)	.....	596, 668	Daruhuld (Pers.)	.....	290
Dadrughna (S.)	.....	668	Daruna (S.)	.....	386
Dagra (Ind. Baz.)	.....	60	Darunisha (S.)	.....	290
Dahaka (S.)	.....	386	Darupita (S.)	.....	290
Dahan (Rajputana)	.....	428	Daruri (Mar. & Dec.)	.....	283
Dahnulefaham (Arab.)	.....	407	Darvi (S.)	.....	289, 290, 293
Dahur karanja (B.)	.....	388	Darya-kaf (H.)	.....	537
Dahya (P.)	.....	526	Darya-kanaryal (H. & Bo.)	.....	602
Daivapala (Mal.)	.....	276	Darzardi (Pers.)	.....	325
Dakhnirbissi (H.)	.....	320	Dasamula (S.)	.....	681
Dakrabo (China)	.....	415	Dasamula kvatha (H.)	.....	430
Daku (Vern.)	.....	376	Dasanamu (Tel.)	.....	510
Dalchini (Kan., Bo., Mar., Tel. & B.)	.....	126	Dashamula (H.)	.....	389
Dalegandhi (S.)	.....	276	Dasi (B.)	.....	505
Dalim (B. & Assam)	.....	522, 683	Datura (Eng.)	.....	50, 134, 672
Dalimba (Bo.)	.....	522, 683	Dattura (P.)	.....	134
Dalimgachh (B.)	.....	522	Davana (Mar., Tam. & Kan.)	.....	71
Dalimma (Tel.)	.....	522	Dayingiwa (Hausa)	.....	353
Dalinm (B.)	.....	599	Deadly night shade (Eng.)	.....	72
Dalkaramcha (B.)	.....	388	Deikna (H.)	.....	363
Dama (P.)	.....	507, 602	Delft grass (Eng.)	.....	613
Damahan (H.)	.....	507, 602	Deobabul (Bo.)	.....	492
Damana (Bo.)	.....	509	Deodar (H.)	.....	499, 596
Daman-papar (H.)	.....	680	Deodari (Bo. & Mar.)	.....	311
Dand (Arab.)	.....	671	Deo-dhan (H. & Bo.)	.....	548
Dandalonbin (Burm.)	.....	364	Deokapas (Bo.)	.....	509
Dande-nahri (Arab. & Pers.)	.....	677	Der (P.)	.....	312
Danikan (Kumaon)	.....	363	Deri (P.)	.....	312
Danti (S., H. & B.)	.....	497, 543, 595, 665	Dermatitis (Eng.)	.....	542, 551, 555
Dantimul (Bo.)	.....	497, 543, 665	Derris (Eng.)	.....	64, 542
Dapoli (Mar. & Bo.)	.....	339, 602, 605	Desman (Eng.)	.....	465
Darab (P.)	.....	312	Devabaram (Mal.)	.....	311
Darakhte-bang (Pers.)	.....	84	Devadaru (S., B. & M.)	.....	499, 596, 602
Darakhtegulchakan (Pers.)	.....	357	Devadri (Tel.)	.....	499
Darakhtegulcha-kanesahrai (Pers.)	.....	356	Devanahuli (Vern.)	.....	568
Darakhte nar (Pers.)	.....	683	Devaspat (Pers.)	.....	297
Darakhte pallah (Pers.)	.....	301	Devataruni (S.)	.....	523
Darakhte-shanah (Pers.)	.....	661	Devavriksha (S.)	.....	276
Darakhte-sibr (Pers.)	.....	61	Devdaru (H. & B.)	.....	520
Darakhtetari (Pers.)	.....	666	Devi (S.)	.....	320
Darau (P.)	.....	557	Devil's cotton (Eng.)	.....	259
Darchini (P.)	.....	126	Devil's nettle (Eng.)	.....	559
Dardur (Vern.)	.....	441	Devil's thorn (S. Africa)	.....	430
Dare jhapak (Santh.)	.....	684	Dewdar (P.)	.....	499
Dar-filfil (Arab. & P.)	.....	682	Dhai (H. & B.)	.....	606
Darhald (H.)	.....	289	Dhak (H.)	.....	301
Darhuld (Pers.)	.....	290	Dhakangu (P.)	.....	579

Dhakur (B.)	.....	316	Dill water (Eng.)	...	216
Dhalakura (B.)	.....	270	Dimba (S. & Bo.)	....	536
Dhala tulasi (Uriya)	.....	680	Dimeri (H.)	..	674
Dhamani (S., H., P. & B.)	509, 598		Dinesam (Mal.)	...	305
Dhamargowa (S.)	... 354		Dingkain (Khasia)	..	523
Dhamasa (Mar.)	.... 507		Dinglatterdop (Khasia)	..	596
Dhan (H. & B.)	.. 518, 600		Dingsa pine (Khasia)		223
Dhana (S. & Bo.)	.. 388, 670		Dingsableh (Khasia)	..	526, 687
Dhananjaya (S.)	.... 421		Dipaka (S.)	..	323
Dhane (B.)	.... 670		Dipika (S.)	..	386
Dhania (H.)	.... 600		Dipta (S.)	..	313
Dhanurdruma (S.)	.. 287		Dirasana (Tel.)	..	493
Dhanvi (S.)	.. 421		Dirghakila (S.)	..	270
Dhanya (S. & H.)	.. 518, 670		Dirghakilaka (S.)	..	270
Dhanyabhra (S.)	... 441		Dirghapadapa (S.)	..	281
Dhanyaka (S.)	.... 600, 670		Dirghapatraka (S.)	..	271, 596
Dhanyamu (Tel.)	.. 518		Dirghaphala (S.)	...	354
Dhaoya (B.)	... 495		Dirgharaga (S.)	..	325
Dharakadambu (S.)	.... 576		Dirmanah (Pers.)	...	65
Dharaphala (S.)	.... 354, 395		Dita (Eng.)	..	277
Dharmana (S.)	.... 509		Dita bark (Eng.)		49, 276
Dharmar (B.)	.... 526		Diva (Bo.)	..	548
Dhataki (S.)	.... 606		Divabhishta (S.)	..	371
Dhatri (S.)	.... 673		Divakar (S.)	...	366
Dhatrighala (S.)	... 497, 605		Diver (Eng.)	..	537
Dhattura (S.)	.... 134		Divya (S.)	..	352, 511
Dhatura (H., B., Mar. & Guj.)	134, 596		Divyapushpa (S.)	....	425
Dhatushya (S.)	... 287		Djinni (Mal.)	..	354
Dhavada (Bo.)	.... 495		Dochunty (B.)	... 603	
Dhavala (S. & Bo.)	.. 421, 559		Dodder (Eng.)	..	329
Dhaura (H.)	.... 495		Dodhak (Bo.)	....	672
Dhek (P.)	.... 363		Dodhi (Bo.)	... 333, 512	
Dhera (H.)	.... 270		Dogwood (Eng.)	..	173
Dheras (B.)	.... 676		Dolakura (Bo.)	..	342
Dhira (S.)	.... 323, 355, 427		Dolaphala (S.)	....	356
Dhmanksholi (S.)	.... 355		Domba (Sing.)	...	667
Dhola akdo (Guj.)	... 305		Dommadolu (Tel.)	....	437
Dholi saturdi (Guj.)	... 297		Dona (B.)	..	595
Dhop-chamni (B.)	.... 341		Dopahari (H.)	....	518
Dhordavana (Mar.)	.... 72		Dorca (C.P.)	..	354
Dhub (H., B. & Bo.)	.... 504, 596, 604		Dori (H.)	....	512
Dhudi (H. & B.)	335, 342, 507, 511		Dosakaya (Tel.)	..	502
Dhumala (S.)	.... 274		Doshahari (S.)	...	401
Dhumrapatra (S.)	.... 496, 577, 664		Dougi (Bo.)	....	287
Dhundul (B.)	.... 546		Doutha (Burm.)	...	671
Dhup maram (Tam.)	.... 689		Dowla (Bo.)	..	342, 529, 606
Dhurva (S.)	.... 504		Drakh (Bo.)	....	530
Dhutura (Bo.)	.... 596		Draksha (S., Tel. & Kan.)	....	530
Dhvankshanakha (S.)	.... 261		Dravi (P.)	....	312
Digitalis (Eng.)	16, 34, 140, 247, 687		Dravida (S.)	...	327
Digitalis leaf (Eng.)	.... 50		Dreck (Kash.)	....	377
Dikamali (Bo.)	.... 597		Drek (P., H. & Bo.)	....	363, 377
Dikmali (H. & Mar.)	.... 597		Dreka (S.)	....	363
Dill (Eng.)	49, 96, 216, 614, 615, 639		Dridhagranthi (S.)	....	287

Dridhakantaka (S.)	.....	270	Edakulaponna (Tel.)	.....	276
Dridhapatra (S.)	.....	287	Edakularati (Tel.)	.....	276
Dridhavalkala (S.)	.....	281	Edikkol (Tam.)	.....	311
Drikaprasada (S.)	.....	311	Ekangi (B.)	.....	327
Drona pushpi (S.)	.....	512, 597	Ekashthila (S.)	.....	320
Drunkan date tree (Eng.)	.....	280	Ekharo (Guj.)	.....	353
Dudh (B.)	.....	504, 596	Ela (S.)	.....	142, 144
Duda-kaha (Sing.)	.....	671	Elam (Tam.)	.....	603
Dudal (P.)	.....	687	Elaparni (S.)	.....	274
Dudcory (Assam)	.....	342	Elchi (Guj.)	.....	142
Dudeli (Guj.)	.....	335	Elder (Eng.)	.....	9
Dudh batthal (P.)	.....	687	Elegaram (Tel.)	.....	685
Dudhia bish (Kash. & P.)	.....	56	Elengi (Malay)	.....	678
Dudhialata (H. & B.)	.....	598	Elephant (Eng.)	.....	535
Dudh kalmi (B.)	.....	517	Elephant cowitch (Eng.)	.....	559
Dudipala (Tel.)	.....	333	Elilaippalai (Tam.)	.....	276
Dudiya (B.)	.....	507, 579	Elilampala (Mal.)	.....	276
Dudla (Bo. & P.)	.....	561	Ellu (Tam.)	.....	685
Dudli (P.)	.....	687	Elumichai (Tam.)	.....	130
Dugdha (S.)	.....	536	Emmenagogue plants (Eng.)	.....	563, 567
Dugdhika (S.)	.....	598	Enamriga (S.)	.....	534
Dukarkanda (Mar.)	.....	526	Enfleurage (Eng.)	.....	617, 618
Dulagondi (Tel.)	.....	515	English belladonna (Eng.)	.....	78
Dulagundi (Tel.)	.....	527	English black mint (Eng.)	.....	199
Dulal labah (B.)	.....	493, 595	English white mint (Eng.)	.....	199
Dumaputu (M.)	.....	534	Enne (Kan.)	.....	510
Dumni (P.)	.....	511	Enugadul agondi (Tel.)	.....	559
Dumparashtrakamu (Tel.)	.....	274	Enuga-pippalu (Tel.)	.....	684
Dumparasna (Tel.)	.....	397	Enugatippali (Tel.)	.....	524
Dumshing (Bhutia)	.....	660	Ephedra (Eng.)	.....	11, 33, 35, 51, 145
Dumtulli (Kash.)	.....	648, 662	Eraminu (M.)	.....	536
Dund (Pers.)	.....	671	Erant (H.)	.....	236
Dundigamu (Tel.)	.....	512	Eranchirbhita (S.)	.....	309
Dungari (Guj. & Sind.)	.....	662	Eranda-gachh (B.)	.....	676
Dunga zha (Sing.)	.....	679	Erant kharbujah (Urdu)	.....	309
Dupada (Tel.)	.....	689	Erendi (Bo.)	.....	236
Dupa-damaru (Tel.)	.....	689	Ergot (Eng.)	.....	33, 50, 540
Duraruha (S.)	.....	267	Ermal (B.)	.....	560
Durba (B.)	.....	504	Errachitramulam (Tel.)	.....	386
Durga chhata (B.)	.....	655	Errakuti (Tel.)	.....	681
Durjara (S.)	.....	313	Erra-tamara-veru (Tel.)	.....	679
Durlabha (S.)	.....	327, 493	Erukata (Tel.)	.....	313
Durmada (S.)	.....	313	Erukkalamipalai (Tam.)	.....	342
Durmogha (S.)	.....	261	Erukku (Tam.)	.....	306
Dusaraitige (Tel.)	.....	501	Erumi-chinarakam (Mal.)	.....	130
Dushta (S.)	.....	402	Eru-saru (Tel.)	.....	687
Dusparsha (S.)	.....	507	Eshopgol (B.)	.....	379
Dusto (Bo.)	.....	598	Esrar (Vern.)	.....	90
Duyutige (Tel.)	.....	427	Essential oil bearing plants (Eng.)	.....	611
Dvitiyabha (S.)	.....	290	Eswaramulla (Mal.)	.....	284
Dzatsutt (Ladakh)	.....	561	Etipuchchha (Tel.)	.....	128
			Ettausirika (Tel.)	.....	519
East Indian screw tree (Eng.)	.....	340	Eucalyptus (Eng.)	.....	51, 167
Edakulapala (Tel.)	.....	276	Euphorbia (Eng.)	.....	336

European aconite (Eng.)	.....	59	Gaimaril (Mar.)	.....	339
European veratrum (Eng.)	.....	10	Gainika (B.)	.....	532
Exile oleander (Eng.)	.....	425	Gairika (S.)	.....	363, 533
Expression process (Eng.)	...	618	Gajaga (Mar.)	.....	499
Eyitror (Ewe.)	.....	353	Gajapipal (H. & B.)	524, 606, 684	
			Gajapippali (S.)	.....	524, 684
Fagari (P.)	.....	597	Gajapippalu (Tel.)	...	684
False pareira brava (Eng.)	..	320	Guj-pipul (B.)	...	684
Farangidhatura (Dec. & H.)	..	283	Gajar (H., B., Bo. & P.)	504, 556, 596	
Farid-buti (H.)	.....	681	Gajjara kelangu (M.)	.....	504, 506
Farisail harin (H.)	.....	534	Gajrah (Bo.)	.....	686
Fasel nut (Eng.)	.....	280	Gala (B.)	.....	538
Felspar (Eng.)	.....	531	Galagara (Tel.)	..	505, 672
Female squill (Eng.)	.....	251	Galani (S.)	...	262
Fennel (Eng.)	51, 176, 177, 178, 221		Galava hemapushpaka (S.)	.....	413
	614, 615		Galavel (Hansot.)	...	426
Fenugreek (Eng.)	.....	615	Galay (Mar.)	..	395
Ferns (Eng.)	.....	647	Galedu (Guj.)	.....	314
Ferox (Eng.)	..	52, 60	Galena (Eng.)	..	532
Fever nettle (Eng.)	.....	559	Gali (Tel.)	.....	312
Fever nut (Eng.)	..	304	Gali chekka (Tel.)	...	685
Field sorrel (Eng.)	..	560	Galijeru (Tel.)	..	528
Filifldray (Pers.)	.....	682	Gallu (Kumaon)	..	687
Filfile-surkh (Pers.)	.....	667	Galo (Guj. & Kaithiawar)	.....	426, 427
Filfiluswud (Arab.)	.....	682	Galonovelo (Kaithiawar)	.....	427
Filix-mas (Eng.)	.....	359	Galot (P.)	.....	500, 604
Firangi dhotra (Mar.)	.....	283	Gam (B.)	..	529
Firanj-mushk (Pers.)	.....	680	Gamari (B. & H.)	.....	509, 675
Fire plant (Eng.)	.....	385, 537	Gambir (Eng. & Malay)	..	374, 689
Flat ganja (Eng.)	.....	88	Ganakasika (S.)	.....	521
Flowering plants (Eng.)	...	541	Ganarupa (S.)	..	306
Flowerless plants (Eng.)	.....	539	Ganasur (Bo.)	..	578
Fofal (Arab.)	..	280	Ganda buti (P.)	..	556
Food poisons	.....	541	Gandak (H.)	..	533
Fowl (Eng.)	.....	536	Gandakam (Tam.)	...	686
Foxglove (Eng.)	.....	137, 138	Gandala (Tel.)	..	672
Frangipani (Eng.)	.....	569	Gandapuro (Java)	...	179
Frankincense (Eng.)	.....	615	Gandar (B.)	.....	538
Fraxinella (Eng.)	.....	556	Gand-babul (H.)	...	492
French sorrel (Eng.)	.....	606	Gandhabena (B.)	..	503, 504, 672
Frog (Eng.)	.....	537	Gandhabhadulia (B.)	...	518, 681
Fufal (Arab.)	.....	280	Gandhagatra (S.)	..	577
			Gandhak (B. & P.)	.....	686
Gab (H. & B.)	.....	505, 604	Gandhaka (S.)	.....	533, 686
Gabbunelli (Tel.)	.....	389	Gandhakam (Tel.)	.....	686
Gachacha-kaya (Tel.)	.....	499	Gandhali (H.)	...	518, 681
Gada (S.)	.....	402	Gandha marjara (S.)	..	538
Gadalshingi (B.)	.....	336	Gandhamulaka (S.)	...	327
Gadancha (B.)	.....	426	Gandhana (Guj.)	.....	681
Gadha (H.)	.....	534	Gandhapalashika (S.)	..	325
Gadhapurna (B.)	.....	297	Gandhapatri (S.)	.....	436
Gado (Guj.)	.....	426	Gandhapyshpa (S.)	..	270
Gaggar (Kash.)	.....	601	Gandharaj (S.)	.....	597
Gahu (Bo.)	.....	529, 549	Gandharash (B.)	.....	501, 670

Gandhasara (S.)	327	Gastropoda (Eng.)	538
Gandha-shati (B.)	510	Gatida (S.)	313
Gandhatrina (H.)	503, 672	Gaugwax (Vern.)	568
Gandhavaruni (S.)	274	Gaura (S.)	323
Gandhilovaj (Guj.)	262	Gauri (S.)	325
Gandhiparna (S.)	276	Gauripushpa (S.)	425
Gandiri (S.)	421	Gautupoka (Tel.)	281
Gandkilakri (Dec.)	262	Gavala (Bo.)	521
Gangai (Assam)	358	Gazelle (Eng.)	465
Gangaravi (Tel.)	527, 688	Gazmazaj (Pers.)	687
Gangarenu (Tel.)	688	Gehela (Bo.)	395
Gangichu (P.)	507, 597	Gehum (H.)	529, 549
Gangird (Pers.)	686	Gel (Mar.)	395
Ganglimethi (H.)	511	Gelaphal (Bo.)	395, 599
Gang-salik (B.)	533	Gendha (S.)	534
Gangwa (B.)	557	Gendum (Mal.)	529
Ganiari (B.)	389, 683	Gentian (Eng.)	33, 181, 250
Ganikarika (S.)	683	Geon (Vern.)	568
Ganira (Vern.)	568	Geranium (Eng.)	36
Ganja (H., B., P., Mar. & Tam.)	84, 85, 86, 87, 88, 89, 90, 91	Gerumati (H.)	533
Ganjamkorai (Tam.)	516	Get-kola (Sing.)	339
Ganjanimma (Tel.)	669	Geva (Bo.)	557
Ganja-yala (Tam.)	87	Geyapal (Bo.)	578
Ganjika (S.)	84	Ghagarabela (H.)	598
Ganjni (H.)	504	Ghalanta (S.)	270
Ganna (H., P. & B.)	523	Ghamur (P.)	598
Gantubharangi (Mar.)	521	Ghaneri (Bo.)	546
Ganugatulsi (Uriya)	597	Gharei kashmalu (H. & P.)	677
Ganzai (Tel.)		Gharol (Bo. & Mar.)	426, 427
Gaozaban (B., H., Tam. & Urdu)	517, 598, 680	Gharshani (S.)	325
Garala (S.)	474	Ghasra (S.)	323
Garalavegam (Mal.)	284	Ghati (Bo.)	685
Garaphala (Mal.)	494	Ghatipitpapada (Bo.)	523
Garbijaur (H.)	598, 601, 677	Ghebu-nelli (Tel.)	683
Gardal (Bo.)	334	Ghee (B.)	675
Garden rue (Eng.)	560	Ghee-kunvar (H.)	61
Gardha-bhanda (S.)	688	Ghela (Bo.)	395
Gardhava (S.)	534	Gherumitti (H.)	533
Garham (P.)	427	Ghet-kochu (B.)	549
Garhjat ganja (H.)	89	Ghetu (B.)	670
Gari (Tel.)	496, 595	Ghetuli (Bo.)	297
Garjan-ka-tel (H. & Bo.)	672	Ghhonta (Mal.)	281
Garjo (Nep.)	427	Ghi (H.)	675
Garlic (Eng.)	271, 273, 274, 614	Ghobe (Guj.)	314
Garuda-mukku (Tel.)	601	Ghol (P.)	314
Garudaphala (S.)	414	Gholsari (M.P.)	678
Garudapu (S.)	356	Ghonta (S.)	281
Garudi (S.)	501	Ghoranim (B.)	363
Garuga (Tam.)	505, 597	Ghor bach (H.)	262
Garum (P.)	427	Ghore sun (B.)	502
Garur (B.)	677	Ghosalata (B.)	546
Gashagasha (Tam.)	202	Ghosali (Bo.)	546
		Ghosha (S.)	377
		Ghrita (S. & B.)	675

Ghrita-kumari (S. & B.)	61	Gokshura (S., H. & Uriya)	353, 528, 599
Ghunchi (Urdu)	261		665, 681
Ghungchi (Bo.)	260	Golainchi (Vern.)	569
Ghusruna (S.)	323	Golap (B.)	523
Gila (H.)	334	Golap-phul (B.)	238
Gilagach (B.)	334	Golden apple (Eng.)	267
Gila-jewa (Assam)	334	Golden seal (Eng.)	293
Gilatige (Tel.)	334	Gold kusth (Urdu)	461
Gill (H.)	532	Gold thread (Eng.)	292
Gilo (P. & Arab.)	426, 427	Golkandra (H.)	598
Giloe (H. & B.)	426	Golmarich (B.)	605
Gilogularich (P.)	427	Golmirich (H.)	520, 598, 605
Gineri (Nep.)	683	Gol-mirich (P.)	682
Gingelly-oil plant (Eng.)	569	Golmorich (B.)	520, 682
Ginger (Eng.)	52, 132, 165, 255, 256, 257	Golomi (S.)	262
	258, 264, 410, 614	Goma (H.)	512, 597
Ginger grass (Eng.)	613, 630	Gomuk (Vern.)	567
Gingli (Vern.)	569	Gondal (B.)	501
Girbuli (Bo.)	72	Gondbadustan (H.)	534
Girdchob (Pers.)	281	Gongura (Tel.)	510
Girimalika (Tel.)	342	Gonsali (Bo.)	354
Giripatra (S.)	363	Gooke (Nep.)	339
Giroli (Bo. & Mar.)	426, 427	Goose-foot family (Eng.)	100
Giun (H.)	529	Gopadala (S.)	281
Gluru (Guj.)	314	Gopichandan (Eng.)	532
Go (S.)	534	Gorakh-amli (H. & Bo.)	493, 603
Goat (Eng.)	535	Gorakhmundi (H. & Bo.)	525, 601
Gohari (Nep.)	56	Gorakshi (S.)	493
Gobhi (S. & H.)	506, 534	Goranebu (B.)	130
Gobria sulah (Nep.)	660	Goranta (Tel.)	677
Gobriya (Darmiya)	56	Gor bach (H.)	262
Goda (B.)	435	Gorinta (Tel.)	597
Godavaj (Guj.)	262	Gorochan (H., B. & Bo.)	534
Godhuma (S.)	529, 549	Gorochana (S., B., Bo. & M.)	533, 534, 535
Godumai (Tam.)	529	Gorochanam (S., B., Bo. & M.)	535, 536
Godumala (M.)	549	Goru (B.)	534
Godumulu (Tel.)	529	Goruma (H.)	506, 600
Gogird (P.)	686	Gorur-champ (Vern.)	569
Gogjimul (Kash.)	597	Gosamp (H.)	537
Goharitaki (S.)	267	Gosampige (Vern.)	569
Gojialata (B.)	506	Goshtam (Tam.)	402
Gojihva (S.)	506	Gostani (Mal.)	530
Gokantaka (S.)	430	Goting (Bo.)	687
Gokharu (Urdu)	430	Gourds (Eng.)	41
Gokhru (B., C.P., H. & Guj.)	353, 430, 528	Gowali (Bo.)	602
Gokhrudesi (P.)	430	Goyya (Tel.)	521
Gokhulajanum (Santh.)	353, 665	Goza (Urdu)	204
Gokhulakanta (H.)	353, 665	Grahaka (S.)	296
Gokhura (S.)	430	Grahanasha (S.)	276
Gokhuri-kalan (H.)	528	Grahanashana (S.)	276
Gokhuru (B.)	430	Grahashi (S.)	276
Gokru (H.)	505	Gramya (S.)	354
Gokru kalan (P.)	681	Granthiphala (S.)	395
		Greater galangal (Eng.)	274

Grecian foxglove (Eng.)	136	Guluncha (B.)	426
Green dove	535	Gulvel (Mar. & Dec.)	426, 427
Grey sarsaparilla (Eng.)	187	Gulwel (Bo., Guj. & C.P.)	426
Groundnut (Eng.)	49, 63	Gumadi (Tam.)	675
Gryashya (Mal.)	371	Gumar (B.)	675
Gua (B.)	280	Gumar-tek (Tel.)	675
Guarana (Eng.)	81, 83	Gumbar (B.)	675
Guarana paste (Eng.)	80	Gumbhari (S.)	509, 600, 675
Guchcha (S.)	504	Gum gugul (Eng.)	285
Guchha pushpa (S.)	276	Gumhar (P.)	509
Guchhian (P.)	656	Gummadi (Tel.)	503, 509
Gudal (P.)	438	Gums (Eng.)	615
Guda pushpa (S.)	356	Gumudu tekku (Tam.)	675
Gudatvak (S.)	126	Gunadhyaka (S.)	270
Gudhapatra (S.)	270	Gunakhiakarai (Vern.)	259
Gudhavallika (S.)	270	Gunara (H.)	508
Guduchi (S. & Tel.)	427	Gunch (B.)	260
Gugal (H., Bo. & Guj.)	285, 501	Gunchi (Mar.)	260
Gugala (B.)	501, 596	Gunda-gilla (B.)	600
Gugall (Bo.)	596	Gundhak (H.)	686
Guggal (H.)	286	Gundhapatra (S.)	270
Guggul (H., B. & Bo.)	285, 286, 600	Gundumeda (Tel.)	313
Guggula (S.)	285	Gunglujungli (Pers.)	597
Guggula-dhup (Bo.)	503	Gunja (S., Bo., Guj. & Mar.)	260
Guggulu (H.)	285	Gunjika (S.)	261
Gugil (Kash.)	367	Guntakalagar (Tel.)	672
Gugul (P.)	287, 367	Gunyun (Kash.)	92, 604
Guguli (Bo.)	495, 595	Guptasneha (S.)	270
Guj (H.)	126	Gurach (H.)	427
Gukkal (Tam.)	285	Gurbiani (B. & P.)	424
Gul (P. & Bo.)	238, 318, 523, 669	Gurcha (H. & Kumaon)	427
Gulab (H. & P.)	523	Gurdlu (P.)	547
Gulabapushpam (Mal.)	523	Gurguli (P.)	577
Gulabi (Kan.)	523	Gurgur (B.)	601
Gulab-ke-phul (H.)	238	Gurivenda (Tel.)	261
Gulancha (B., H. & Kumaon)	426, 427	Gurjia (Tel.)	261
Gulappu (Tam.)	238	Gurkamai (B.)	685
Gular (H.)	508, 597, 604, 674	Gurlpata (Kumaon)	411
Gulavel (Mar.)	427	Gurmur (H.)	336, 337
Gulavela (Mar.)	427	Gurol (Assam)	395
Gulbel (H., Dec. & Pers.)	426, 427	Gurrapukattiyaku (Tel.)	322
Gulchiu (Vern.)	569	Gurtakand (B.)	305
Guldupaharia (P.)	518	Guruginja (Tel.)	261
Gulechakan (Pers.)	356	Guthava (H.)	296
Gul-kakru (P.)	226	Gutika (H.)	532
Gulkand (H. & Vern.)	238	Guvaini (N.W.P.)	367
Gul-khair (H.)	598	Guvaka (S.)	281
Gulmirch (H.)	682	Guvvagutti (Tel.)	528
Gulo (Dec.)	426	Guya-babula (B.)	492
Guloe (Bo. & Mar.)	426, 427	Gwal (P.)	688
Guloe-ka-sat (H.)	427	Gwali (Kumaon)	173
Gulsakari (H.)	606	Gwel (Mal.)	314
Gulseoti (P.)	523	Gypsum (Eng.)	531
Gulu (M., P. & Bo.)	525		

Habbul-aaraar (Arab.)	195	Harivera (S.)	605
Habbulfahm (Arab.)	407	Harjouri (H.)	320
Habbul-mishk (Arab.)	676	Harjora (B., H. & Bo.)	669
Habbussala (Arab.)	665	Harkai chanda (H.)	397
Hebelkalb (Arab.)	407	Harkaya (Mar.)	397
Habessoudan (Arab.)	311	Harle (Bo.)	688
Habulban (Arab.)	363	Harmal (H. & Arab.)	368, 555
Habulkalab (Arab.)	407	Harmala (Arab.)	368, 369
Habul-kalkal (P.)	667	Harmol (H.)	369
Hadialgusilutta (B.)	329	Haro (Vern)	568
Haimavati (S.)	290	Harrar (P.)	688
Hairy wild vine (Eng.)	555	Harsankar (H. & Bo.)	669
Hajar-ul-musa (Arab.)	457	Harsingara (B.)	516
Hakuch (B.)	391	Harsinghar (P., H. & B.)	516, 698
Haladi (S. & Urdu)	325	Harvali (Tel.)	504, 596
Haldar (P.)	325	Haryali (Mar.)	504
Haldi (H. & B.)	325, 326	Hasak (P.)	528
Haldigach (B.)	293	Hashish (Egypt)	89, 90
Haldu (H.)	576, 595	Hasjora (B.)	669
Halede (Mar.)	325	Hasti (S.)	535
Halela (P.)	688	Hastipata (Bo.)	506
Halim (B., H., P. & Vern.)	508, 598	Hastisunda (S.)	510, 545
Halja (P.)	325	Hat (H.)	342
Halyun (H.)	555	Hatavari (Sing.)	665
Hamana (H.)	547	Hatechanghara (H.)	430
Hand (P.)	318	Hathela-ghugu (B.)	535
Handakuki (Arab.)	297	Hati (B.)	535
Hans (B.)	534	Hatisura (H. & B.)	510, 545
Hansa (S.)	534	Hatmul (Assam)	665
Hansapadi (S. & Guj.)	534, 648, 662	Havirmantha (S.)	389
Hansa-vati (S.)	493, 648	Hayamara (S.)	425
Hansraj (Bo. & H.)	493, 603, 662	Hayapriya (S.)	436
Happy tree (Eng.)	311	Hayari (S.)	425
Hapusha (S.)	682	Hayarmani (H. & B.)	598
Har (H., P. & Bo.)	688	Hazarmani (H. & B.)	519
Harara (H.)	688	Heera (H.)	531
Hara-tutia (H.)	531	Heeraka (S.)	531
Harbhanga (B.)	669	Hejurchi (B. & H.)	598
Harda (Bo.)	688	Hemadugdha (S.)	283
Hardi (Bo.)	688	Hemajivanti (S.)	333
Harhuria (Mar.)	321	Hemakanti (S.)	290
Harial (H.)	535	Hemakshiri (S.)	333
Harichandana (S.)	323	Hemapurna (S.)	333
Haridra (S.)	290, 325	Hemaragi (S.)	325
Haridram (Mal.)	293	Hemashikha (S.)	283
Harilali (H.)	504	Hemavalli (S.)	333
Haripriya (S.)	425	Hemavati (S.)	283
Harir (H.)	527, 548	Hemavha (S.)	333
Harira (H.)	602	Hemda (Arab.)	681
Harita (S.)	325, 535	Hemkranta (S.)	290
Haritaki (S., B. & H.)	444, 527, 548, 602, 688	Hemp (Eng.)	34, 85, 86, 87, 89, 90, 91, 204
Haritala (S., B. & Bo.)	531	Henbane (Eng.)	89, 91, 189, 190, 191, 192
Haritali (S.)	504	Henduripoma (Assam)	311
Harita-manjiri (Tel.)	661	Henna attar (H.)	633

Heron (Eng.)	534	Horse (Eng.)	535
Hijal (B.)	497, 603	Horse purslane (Eng.)	570
Hij-daona (B.)	673	Hrasvagni (S.)	386
Hijjal (H.)	497, 603	Hrivera (S.)	681
Hijli badam (B.)	555, 577	Hsaythanpaya (Burm.)	579
Hijrata hau (H.)	533	Hulhul (H., P. & Urdu)	321, 669
Hikua (B.)	555	Hulluch (Assam)	527
Hilikha (Assam)	527	Hulugiri (Bo.)	558
Hilsa (H.)	535	Hum (Pushtu)	145
Himadruma (S.)	363	Hunjika (Tel.)	500
Himalayan blue pine (Eng.)	124	Hura (Bo.)	413
Himarati (S.)	386	Hurh (P.)	688
Hina (Urdu)	614	Hurhur (H.)	321, 669
Hin-bin-tal (Sing.)	671	Hurhureh (H.)	321
Hindiagara (Bo.)	495	Hurhuria (B. & Bo.)	321, 500, 579, 669
Hindi sana (H.)	98	Hurmaro (Bo.)	368
Hindubar (Arab.)	318	Hurmul (P., Bo., Arab. & Sind.)	368
Hindyba (Arab.)	669	Hursini (S.)	84
Hing (H. & B.)	174	Hussuk (H.)	430
Hingan (H. & B.)	496, 595	Hutabhuk (S.)	386
Hinganbet (Bo.)	496	Huyer (B.)	501, 600
Hingool (H.)	450	Huziru (Bo.)	514
Hingra (H., B. & Bo.)	174	Hyacinth (Eng.)	614
Hingu (S.)	174	Hyoscyamus (Eng.)	33, 36, 185, 430
Hirabol (Guj. & Cutch.)	670	Hyssop (Eng.)	613
Hirada (Bo.)	688		
Hirakas (B.)	673	Ich-chura-muli (Tam.)	664
Hira-kashish (Bo.)	673	Idalimbu (Mar.)	130
Hira kasis (H.)	673	Iguana (Eng.)	537
Hira-kosis (B.)	673	Ikshu (S., Kan. & Mal.)	523
Hirankhori (Bo.)	604	Ikshugandha (S.)	353, 430
Hiranpaddi (P.)	501	Ikshuparni (S.)	262
Hiranpadi (H.)	501, 544	Ikshura (S.)	353
Hiranpag (Bo.)	501, 544	Ikshuvalika (S.)	353
Hirantutiya (H.)	131, 132	Ilaikalli (Tam.)	507
Hiranvel (Mar.)	518, 681	Ilaik-kalli (Tam.)	673
Hiranyatutha (S.)	131, 132	Ilandai (Tam.)	602
Hirda (Bo.)	527, 548, 688	Ilanji (Tam.)	388
Hiruseeah (H.)	556	Ilayangam (Tam.)	126
Hirtiz (Kash.)	557	Ilayechi (H.)	603
Hoge sappu (Kan.)	679	Ilis (Bo.)	535
Hog gum (Eng.)	366	Illi (Mal.)	287
Hogla (B.)	606	Illisa (S.)	535
Hogweed (Eng.)	297	Ilukkatti (Tel.)	511
Holly (Eng.)	83	Iluppai (M. & Tam.)	357
Holy fruit (Eng.)	267	Imalam (Tam.)	293
Honey (Eng.)	536	Imalbel (Urdu)	329
Honey bee (Eng.)	534	Imli (H., P. & Bo.)	526, 686
Honey tree (Eng.)	357	Inchi grass (Vern.)	613
Hongay oil (Eng.)	388	Indai (Bo.)	675
Hookworms (Eng.)	100	Indar-javetalkh (Pers.)	342
Hopari (Guj.)	281	Inderjantulkh (Bihar)	342
Hops (Eng.)	558, 597	Indian acacia (Eng.)	49
Hora (B.)	688	Indian acalypha (Eng.)	49

Indian aconite (Eng.)	54, 56	Ingini (Sing.)	686
Indian antelope (Eng.)	534	Ingudi (S.)	313, 395, 496
Indian barberry tree (Eng.)	289	Inguva (Tel.)	174
Indian beech (Eng.)	388	Intellect tree (Eng.)	313
Indian belladonna (Eng.)	49, 72, 79	Ipecac (Vern. & Eng.)	50, 229
Indian birthwort (Eng.)	284	Ipecacuanha (Eng.)	16, 20, 31, 33, 34, 229, 230, 231, 233, 266, 307, 344, 382, 395, 431, 432, 677
Indian blistering beetle (Eng.)	472	Ippa (Tel.)	357
Indian bottle gourd (Eng.)	466	Ippichaphada (Mar.)	357
Indian cassia bark (Eng.)	125	Irainji (Tam.)	279
Indian cassia lignea (Eng.)	125, 126	Iraivarai (Tam.)	288
Indian chenopodium (Eng.)	102	Iratimadhuram (Mal.)	260
Indian colchicum (Eng.)	131	Irevalsinni (Tam.)	509
Indian crane (Eng.)	534	Irippa (Mal.)	356, 357
Indian dill (Eng.)	216	Irippapu (Mal.)	356
Indian gentian root (Eng.)	181	Irisa (P.)	676
Indian ginger (Eng.)	258	Iron pyrites (Eng.)	532
Indian henbane (Eng.)	191	Irosa (Tam.)	523
Indian hyoscyamus (Eng.)	189	Irsa (Arab.)	676
Indian lemon peel (Eng.)	131	Irulli (Tam.)	494, 662
Indian lilac (Eng.)	360, 363	Iruppai (Tam.)	357
Indian liquorice (Eng.)	186, 260	Isabagola (Mar.)	379
Indian mahogany (Eng.)	311	Isabghol (P.)	379
Indian napellus (Eng.)	56, 59, 60	Isabghul (H. & Pers.)	379
Indian nut tree (Eng.)	281	Isabgul (B. & Vern.)	51, 379
Indian oleander (Eng.)	568	Isadesatti (Tam.)	284
Indian pennywort (Eng.)	351	Isafghol (Guj. & P.)	379
Indian podophyllum (Eng.)	51, 226	Isapagala (Tel.)	379
Indian squill (Eng.)	251	Isapghol (Guj. & Bo.)	379
Indian quince (Eng.)	267	Isarmul (B.)	284
Indian rhubarb (Eng.)	233	Isabghol (H.)	379
Indian saffron (Eng.)	325	Isband (Pers. & B.)	368
Indian sarsaparilla (Eng.)	51, 187, 188	Isband-lahouri (H.)	368
Indian senna (Eng.)	51, 98	Isboundlahouri (P.)	368
Indian skink (Eng.)	537	Isgand (P.)	436
Indian squill (Eng.)	52, 251	Ishadgola (S.)	379
Indian valerian (Eng.)	253	Isha langulya (B.)	597
Indian wintergreen (Eng.)	179, 180	Ishappukol (Tam.)	379
Indian wormwood (Eng.)	72	Isharmul (H.)	284, 664
Indrabam (Tam.)	342	Ishshwari беру (Kannada)	285
Indradru (S.)	421	Ishvara (S.)	284
Indradruma (S.)	421	Ishvaramuri (Mal.)	340, 664
Indragopa (H.)	536	Ishvara-veru (Tel.)	664
Indrajab (Bihar)	342	Ishvari (S.)	284
Indrajau (B.)	530, 599, 606	Ishveri-veru (Kan.)	664
Indrak (Guj.)	128	Ishwari (S.)	397
Indra-maris (Uriya)	661	Iskol (Tam.)	379
Indranan indravana (Guj.)	128	Ismogul (Kash.)	379
Indravadhi (S.)	536	Ispaghul (P.)	379
Indrayan (H., B., Mar. & Urdu)	128	Ispaghul (H., B., Urdu & N.W.P.)	379
Indrayava (S.)	342, 346	Ispaghula (Eng. & Vern.)	347, 350, 379, 380, 383
Induga (Tel.)	686	Ispand (Bo., Urdu & Pers.)	368
Indur (B.)	536		
Indyba (Arab.)	318		
Ingai (Tam.)	514		

Kachhaka (S.)	312	Kaidaryamu (Tel.)	515, 678
Kachi (Tel.)	685	Kaikeshi (Tam.)	672
Kachi grass (Vern.)	613	Kail (H.)	223
Kachmach (P.)	685	Kailaya (H.)	353
Kachnal (H.)	497, 595, 600	Kaimbil (Kash.)	358
Kachnar (H.)	497, 595, 600, 603	Kaiphal (H., P., B. & Bo.)	515, 605, 678
Kachoram (Tel.)	274	Kaipruchindil (Tam.)	427
Kachroora (H.)	615	Kaisara (S.)	323
Kachura (II., Bo. & B.)	327	Kaitarya (S.)	363
Kachuri (Guj.)	327	Kaivalanara (Mal.)	340
Kachur-kachu (P.)	675	Kaiyappudai (M.)	580
Kachwassal (P.)	251	Kaiyuna (Mal.)	340
Kada kai (Tam.)	688	Kajjali (S.)	449, 450
Kadalalari (M.)	316	Kajjli (H.)	454
Kadali (S.)	515, 678	Kajra (Bo.)	248
Kadalma (Tam.)	316	Kaju (H. & Bo.)	555, 577
Kadamba (S., Bo. & H.)	495, 603	Kak (B.)	535
Kadambamu (Tel.)	495	Kaka (S.)	535
Kadapa (Tel.)	497	Kakadani (S.)	596, 600
Kadapara (Tel.)	664	Kakadi (Bo.)	502
Kadappai (Tam.)	497	Kakadumbura (S.)	508
Kadari (Tam.)	293	Kakajangha (S., II. & B.)	601
Kada-todali (B.)	296, 428	Kakakodise (Tel.)	342
Kadavanchi (Vern.)	568	Kakakshi (S.)	518
Kadavinayi (Bo.)	673	Kakamach (S.)	525
Kado (Burm.)	465	Kakamachi (S. & B.)	548, 685
Kadugu (Tam.)	498, 509	Kakamari (Tel. & B.)	404
Kadukadalegida (Kan.)	598	Kakammal (P.)	674
Kadukar (Tel.)	688	Kakani (Mal.)	260
Kadukavata (Mar.)	414	Kakaphala (Bo. & Tel.)	431, 494, 577
Kadukavatha (Bo.)	414	Kakar (P.)	377
Kadukakai (Tam.)	527	Kakaronda (H.)	498, 505
Kaduk-kay (Tam.)	688	Kakashimbi (S.)	261
Kaduk-kaypinji (Tam.)	688	Kakar singi (Pers. & Urdu)	336
Kadukkay-pu (M.)	548	Kakatundika (S.)	261
Kadula (Bo.)	284	Kakavallari (S.)	261
Kadu padavala (Bo.)	688	Kakavalli (Mal.)	559
Kaduvrindavana (Mar.)	128	Kakdumur (B.)	508
Kadvo jiri (Guj.)	434	Kakekshu (S.)	353
Kaemmara (S.)	287	Kakhas (P.)	651
Kaghzinimbu (B. & H.)	130	Kakicheraku (Tel.)	523
Kagittam (Tam.)	431	Kakil-akshya (S.)	603
Kagodagi (Tam.)	313	Kakini (S.)	261
Kagoli (Tam.)	597	Kakkanan (M.)	501, 544
Kagphulai (Nep.)	560	Kakkar (P. & Kash.)	377
Kahi (P.)	523	Kakkar tamaku (P.)	580
Kahoo (H.)	601	Kakkattan (Tam.)	511
Kahruba (H.)	689	Kakkay-killi-virai (M.)	577
Kahu (P., B. & H.)	421, 597	Kakkeran (P.)	377
Kahua (H. & C.P.)	421	Kakkrangche (P.)	377
Kahvah (Arab. & Ind. Baz.)	79	Kakkrein (P.)	560
Kahweh (Vern.)	80	Kakla (B.)	356
Kai (B.)	533	Kakmachi (S. & B.)	525, 548, 599, 606, 685
Kaidai (Darjeeling)	413	Kakmari (S., H. & Guj.)	494, 577

Kaknajehindi (Pers. & Arab.)	.....	436	Kaligam (Tam.)	.....	313
Kakoli (S.)	.....	355	Kaligottu (Tel.)	.....	526
Kakra (H., B., Kumaon, Guj., Mar. & Urdu)	.....	377	Kalihaladi (H.)	.....	327
Kakra-singi (H., B., Pers. & Urdu)	.....	336, 523, 560	Kalihari (H.)	.....	509, 579
Kakri (Bo. & H.)	.....	502	Kali jhant (H. & B.)	.....	493, 603, 648
Kakria (H.)	.....	301	Kalijira (B.)	.....	516
Kakundanrangul (C.P.)	.....	313	Kali-jiri (Bo.)	.....	434
Kakur (B.)	.....	502	Kalikari (S.)	.....	675
Kakur siris (B.)	.....	493	Kali-ka-chuna (H.)	.....	531, 666
Kala (S. & B.)	.....	436, 515	Kali kutki (P.)	.....	181
Kalaakola (Bo.)	.....	270	Kalileh (Urdu)	.....	358
Kaladana (H., B. & Bo.)	.....	194, 368, 511	Kalimusli (H. & Bo.)	.....	503, 671
Kaladanah (H., B. & Bo.)	.....	194	Kalingam (Tam.)	.....	342
Kalahad (Guj.)	.....	498	Kalisam (Tam.)	.....	521
Kalai (P.)	.....	666	Kali sarson (B. & H.)	.....	498
Kalaippaik-kishangu (Tam.)	.....	675	Kali tori (P.)	.....	677
Kala-jam (B.)	.....	686	Kaliyaka (S.)	.....	290
Kalajira (H., B. & Vern.)	.....	516, 569, 580, 680	Kalkani (Kumaon)	.....	313
Kalak (Bo. & Konkan)	.....	287, 665	Kalkashunda (B.)	.....	490
Kalakado (Bo.)	.....	530	Kalkora (B.)	.....	600
Kala khaparo (H.)	.....	533	Kallak (Mar.)	.....	287
Kalambam (Tam.)	.....	313	Kallal (Mal.)	.....	527
Kalambi (S.)	.....	546	Kalli (Tam.)	.....	507
Kala miri (Bo. & Guj.)	.....	520, 598, 682	Kallichhi (Tam.)	.....	508
Kala-mucha (B.)	.....	548	Kalmegh (B.)	.....	49, 278
Kalamula (S.)	.....	386	Kalmisak (B.)	.....	546
Kalanduru (Sing.)	.....	672	Kalmungil (Tam.)	.....	505
Kala-nimak (H.)	.....	532	Kalo bikhoma (Sikkim)	.....	57
Kalanzo (Burm.)	.....	414	Kalonji (H.)	.....	516
Kalaphnath (Dec.)	.....	278	Kalonji mugrela (Vern.)	.....	569
Kalappa-gadda (Tel.)	.....	675	Kalpaka (S.)	.....	327
Kalarsikkodi (Tam.)	.....	603	Kalpam-chettu (Tel.)	.....	84
Kalasaka (S.)	.....	501, 596, 604	Kaltu (H.)	.....	557
Kala-sarshapa (S.)	.....	498	Kalu (Bo.)	.....	537
Kala siris (H.)	.....	493	Kaludaipalai (Tam.)	.....	431
Kalaskanda (S.)	.....	371	Kaludi (Kan.)	.....	526
Kala-til (B. & Vern.)	.....	569, 684	Kaluduru (Sind. & Sing.)	.....	92, 680
Kala tulshi (H. & B.)	.....	516, 605	Kalu-kera (B.)	.....	602
Kala vala (Bo.)	.....	605	Kalunnu (Mal.)	.....	281
Kalavankabija (Kan.)	.....	353	Kamachipillu (Tam.)	.....	504
Kalaw (Burm.)	.....	414	Kamakher (B.)	.....	504
Kalawni (Burm.)	.....	414	Kamakshi grass (Vern.)	.....	613
Kalawso (Burm.)	.....	414	Kamakshi-pillu (Mal.)	.....	504
Kalehar (H.)	.....	688	Kamal (Tam. & P.)	.....	333, 358
Kalenjire (Bo.)	.....	516, 580, 680	Kamala (S. Bo., H., Vern. & Tam.)	.....	125, 358, 359, 679
Kaleyaka (S.)	.....	323	Kamalagundi (B.)	.....	358
Kalgaivalli (Tam.)	.....	559	Kamalphul (P.)	.....	181
Kalhudaityumbai (Tam.)	.....	528	Kamanchi (Tel.)	.....	525
Kaliakara (B.)	.....	596	Kamatha (S.)	.....	287
Kaliar (H.)	.....	497	Kambaila (Peshawar)	.....	358
Kali basuti (P.)	.....	670	Kambal (P.)	.....	358
Kalidudhi (H.)	.....	511	Kambali (Tam.)	.....	515
			Kambari (H.)	.....	600

Kambei (P.)	.....	685	Kanduri-ki-bel (H.)	.....	314
Kambhal (H.)	.....	358	Kandyari (P.)	.....	524
Kambila (H.)	.....	358	Kaner (H., P. & Vern.)	.....	515, 568
Kamboji (S.)	.....	261	Kanga (S.)	.....	262
Kambosam (Tam.)	.....	358	Kangani (Mar.)	.....	313
Kambuka (S.)	.....	436	Kanghani (H.)	.....	661
Kambul (Tam.)	.....	288	Kanghi (H.)	.....	595, 603, 661
Kambumalini (S.)	.....	438	Kangoi (Bo.)	.....	661
Kambupuspha (S.)	.....	438	Kangori (Bo.)	.....	492, 595, 661
Kamela (P., H. & Bo.)	.....	358	Kanguni (Bo.)	.....	313
Kamila (B.)	.....	358	Kanhera (Bo.)	.....	515
Kamini (S. & B.)	.....	290, 605, 616	Kaniar (H.)	.....	599
Kamkshikasuvu (Tel.)	.....	504	Kanichi (S.)	.....	261
Kammar-kas (Bo.)	.....	684	Kanilam (Tam.)	.....	386
Kammul (Simla)	.....	289	Kanj (H.)	.....	428
Kammula (Simla)	.....	290	Kanja (H.)	.....	388
Kampileh (Arab.)	.....	358	Kanjanam (Mal.)	.....	497
Kampilla (S.)	.....	358	Kanjani (Tam.)	.....	497
Kampu (Mal.)	.....	287	Kanjini (Tel.)	.....	497
Kamrup (B. & H.)	.....	508, 597	Kankala (Bo.)	.....	520
Kamrupa musk (Vern.)	.....	467, 470	Kankarola (S.)	.....	270
Kamue muluki (Arab.)	.....	93	Kankati (S.)	.....	492
Kamugu (Tam.)	.....	281	Kankelli (S.)	.....	401
Kamuka (Mal.)	.....	281	Kankra (B.)	.....	538
Kamuna (Arab.)	.....	93	Kankri (Bo.)	.....	502, 578
Kamuni (Bo.)	.....	685	Kankuti (Mar.)	.....	311
Kamurpini (S.)	.....	436	Kannichi (Tam.)	.....	527
Kanak (P.)	.....	529	Kanocha (P.)	.....	684
Kanaka (S.)	.....	134	Kanphodi (Mar.)	.....	321
Kanak champa (B. & Bo.)	.....	599	Kanphul (P.)	.....	687
Kanako (Burm.)	.....	671	Kanphuti (Bo. & H.)	.....	321, 544, 600
Kanana eranda (S.)	.....	676	Kanphytia (H.)	.....	321
Kananottha (S.)	.....	311	Kans (H.)	.....	523
Kanbela (Pers.)	.....	358	Kansa (H.)	.....	601
Kanchana (S.)	.....	428	Kanseri (Vern.)	.....	568
Kanchanam (Tel.)	.....	497	Kanta (S. & Simla)	.....	312, 430
Kanchi (S.)	.....	261	Kantabans (H.)	.....	287
Kanchi-pundu (Tel.)	.....	685	Kantajati (B.)	.....	595
Kanchkuri (Bo.)	.....	527, 548	Kantakalika (B.)	.....	353, 665
Kanchuki (Mar.)	.....	436	Kantakari (S. & B.)	.....	525, 686
Kanchuri-vayr (M.)	.....	548	Kantaki (S.)	.....	287, 395
Kanda (S., Tel. & Bo.)	.....	494, 600, 601, 662	Kantakulika (Bihar)	.....	353
Kandakilaka (S.)	.....	413	Kantala (S. & H.)	.....	577, 595
Kandam (Tam.)	.....	261	Kantalaka (S.)	.....	312
Kandanaguliyam (Tam.)	.....	274	Kantalu (S.)	.....	505
Kandangattiri (Tam.)	.....	525	Kantam (Vern.)	.....	446
Kandanila (S.)	.....	413	Kanta notay (B.)	.....	441
Kandan-kattiri (Tam.)	.....	686	Kantaphala (S.)	.....	430
Kandavela (Bo.)	.....	669	Kantedhotra (Mar.)	.....	283
Kande (H. & B.)	.....	251	Kantel (Mar.)	.....	414
Kandekshu (S.)	.....	353	Kantela (N.W.P.)	.....	283
Kandi (Tam.)	.....	281	Kantha (S.)	.....	395
Kandiari (H. & P.)	.....	283, 525, 530	Kanthal (H. & B.)	.....	496, 595
Kanduri (P. & H.)	.....	314, 596	Kanthari (H.)	.....	596

Kanthiravi (S.)	264	Karikkolam (Tam.)	270
Kanwal (H. & P.)	679	Karinga (M. & Bo.)	351, 597, 668
Kanyo-mi (Burm.)	665	Karinkara (Mal.)	526
Kaolinum (Eng.)	532	Karinkolla (Mal.)	311
Kapalam (Mal.)	309	Karintakara (Mal.)	522
Kapas (H., B., Bo., P. & Vern.)	509, 568, 597, 604	Kariphal (Guj.)	678
Kapela (Bo.)	358	Karit (Vern.)	567
Kaphal (P.)	678	Karisha-langanni (Tam.)	672
Kapidruma (S.)	274	Karitaki (Tel.)	527
Kapila (Mal. & Tam.)	358	Karivana (Bo.)	351, 668
Kapitana (S.)	281	Kariyatu (Guj.)	278
Kapittha (S.)	508	Kariye harni (Vern.)	569
Kapota (S.)	535	Kariz (Arab.)	296
Kappal-melaka (Mal.)	667	Karkani (Bo.)	605
Kapur (Vern.)	120	Karkannie (Bo.)	672
Kapurakachali (S. & Guj.)	671, 675	Karkataka (S.)	538
Kapurakachari (Mar.)	510	Karkatakashringi (Kan.)	523
Kapur kachri (H. & P.)	675	Karkatasringi (S. & Mal.)	379, 523
Kapur krachari (Mar.)	675	Karkatavha (S.)	267
Kapurli (Bo.)	495	Karkati (B.)	537
Kara (Mal.)	395	Karkatini (S.)	290
Karabi (B.)	515	Karkkadagachingi (Tam.)	523
Karachunai (M.)	548	Karkkarasringi (Tel.)	523
Karadu (Mar.)	296	Karkotaki (S.)	354
Karail (B.)	505	Karla (Bo.)	602
Karaka (Tel.)	688	Karlajuri (B.)	596
Karakkaya (Tel.)	688	Karmal (H.)	603
Karala (B.)	602	Karmmaram (Mal.)	287
Karalia (H.)	509, 579	Karmmosu (Mal.)	309
Karamatta (S.)	281	Karmora (Kash.)	558
Karangalli (Tam.)	492	Karmuj (B.)	388
Karangu (H.)	596	Karnaikilangu (Tam.)	494
Karanj (P. & Bo.)	388	Karnari (S.)	421
Karanjaka (H.)	388	Karnasphota (S.)	544
Karanju (H.)	499	Karnika (S., Tel. & Sing.)	336, 389, 521, 683
Karanjwah (Urdu)	388	Karnikara (S.)	599
Karankolam (Mal.)	270	Karotio (Guj.)	667
Karankusa (B.)	596	Karoya (Arab. & Pers.)	92
Karavi (S. & Bo.)	397, 667	Karpas (S.)	604
Karavira (S. & Vern.)	425, 515, 568	Karpasamu (S.)	509
Karaviram (Ham., Tel. & Mal.)	515	Karpasi (S.)	597
Karawya (Arab.)	92	Karppuravalli (Tam.)	495
Karchi (H.)	342	Karpur (S., B. & Vern.)	120, 510, 598
Karchura (S.)	327, 510	Karpura-haridra (S.)	503
Kardhanka (Bo.)	537	Karpuram (Vern.)	120
Karela (H., P. & Vern.)	598, 602	Karpura maram (Tam.)	167
Karhar (H. & Kumaon)	395	Karpuravalli (Tam. & Tel.)	495, 501
Kari (H., Bo. & Santh.)	342, 602, 670	Karra (H.)	342
Karial (P.)	330	Karrai (H.)	525
Karianag (Bo.)	509, 579, 675	Kar-shunnambu (Tam.)	666
Kariari (P. & H.)	509, 675	Karshya (S.)	327
Karihari (H.)	675	Karttikaik-kishangu (Tam.)	675
Kari-jirigi (Kan.)	680	Karu (B. & H.)	181, 509

Karudakkodi (Tam.)	284	Kasturi pasupa (Tel.)	671
Karuk (P.)	367	Kasturitumma (Tel.)	492
Karukkapallu (Mal.)	284	Kasturivel (Tam.)	492
Karumbu (Tam.)	523	Kasturi-vendaik-kay-virai (Tam.)	676
Karunaik kizhangu (M.)	549	Kasuri (Nep.)	173
Karunganam (Tam.)	311	Kasuru (H. & B.)	524
Karunjiragam (Tam.)	516	Kata (S. & Assam)	287, 289
Karunshiragam (Mal.)	516	Katai (H.)	686
Karun-shirogam (Tam.)	680	Kataka (S.)	526, 686
Karupakatuka (Mal.)	498	Katakam (Mal.)	526
Karupali (Tam.)	522	Katakamu (Tel.)	526, 686
Karuppukkadugu (Tam.)	498	Katala (S.)	534
Karupumarudu (Tam.)	527	Katalati (Mal.)	662
Karuppuvalinjil (Tam.)	270	Katalivegam (Mal.)	284
Karuvagei (Tam.)	493	Katambi (Bo.)	674
Karu velum (Tam.)	492, 661	Katankati (S.)	289
Karvaindarjau (H.)	342	Katat (Burm.)	671
Karvat (Bo. & Mar.)	279	Katbish (B.)	51
Karvati (Bo.)	526	Kateli (H.)	525, 686
Karwah (N.W.P.)	283	Kateri (S.)	289
Kasamarda (S.)	499	Katha (Sind. & H.)	309, 661
Kasani (Guj. & Urdu)	318, 669	Kathal (H. & B.)	496, 595
Kasanotpatana (S.)	264	Kathbel (B.)	508
Kasappuveopalai (Tam.)	342	Kathgular (P.)	674
Kaseru (P.)	524	Kathi (Sind.)	274
Kaseruka (S.)	524	Kathillaka (S.)	297
Kash (B.)	523	Kath kutha (H.)	689
Kasha (S.)	523	Kathunerinjal (Malay)	681
Kashini (Tam.)	318	Katkaranj (H.)	304
Kashini-virai (Tam.)	669	Kat-karanja (H.)	499
Kashira chanmpa (S.)	598	Katki (H. & B.)	181
Kashish (Bo.)	673	Katkudagu (Mal.)	321
Kashmal (H., P. & Simla)	289, 290, 292	Katla (B.)	534
Kashmala (Simla)	290	Katnim (H.)	605
Kashmar (H.)	289	Katong (Lep.)	561
Kashmira musk (Eng.)	470	Katphala (S.)	515, 678
Kashtha (S.)	290	Katreiriki (Sing.)	353
Kashus (Arab.)	329	Katri (Bo.)	689
Kasinda (Tel.)	499	Katsi (P.)	283
Kasini (Tel.)	318	Katsol (Vern.)	569
Kasini-vittulu (Tel.)	669	Kattamanakku (Tam.)	677
Kasis (H.)	673	Kattanam (Tam.)	509
Kasisa (S.)	531, 673	Kattang (C.P. & H.)	287
Kasmal (P.)	289	Kattarali (Tam.)	316
Kasmar (Santh.)	675	Kattatti (Tam.)	505
Kasni (H., P. & Pers.)	318, 669	Katthu-olupoe (Tel.)	688
Kasondi (H.)	499	Kattiluppai (Tam.)	356
Kastel (Mar.)	414	Kattinta (Mal.)	519
Kasturi (H., B., S., Tam., Tel., Guj. & Mar.)	465, 536	Kattirippa (Mal.)	356
Kasturi-arishina (Kan.)	671	Kattu elupay (Tam.)	688
Kasturi-benda vittulu (Tel.)	676	Kattukkodi (Tam.)	501
Kasturi-manjal (Tam. & Tel.)	503, 615	Kattukol (Tam.)	311
Kasturi munai (M.)	534	Kattuma (Tam.)	316
		Kattumari (Vern.)	569

Kattumurungai (Tam.)	264	Keli kadam (B.)	576
Kattunaranna (Mal.)	395	Kendu (Uriya)	596
Kattuppepudal (Tam.)	688	Kenika (Malay)	339
Kattu-shenkottai (Tam.)	561	Kenya pyrethrum (Eng.)	106
Kattushiragam (Tam.)	434	Keor (Kash.)	342
Kattusinikka (Mal.)	514	Keore-ka-mul (H. & Bo.)	676
Kattuvalamara (M.)	544	Ker (Bo.)	603
Kattuvalli (Mal.)	320	Keraita (P.)	424
Katu ayamoddakam (Mal.)	102	Kering (Assam)	681
Katuka (S.)	181	Kermes mineral (Eng.)	531
Katukanda (S.)	271	Kerukoh batu (Malay)	339
Katukka (Mal.)	527	Kesari (H.)	173
Katuku-rohani (Tam.)	181	Keshamushti (S.)	363
Katul (Gond)	395	Keshuri (B.)	672
Katunerinjal (Mal.)	518	Kesun-ni (Burm.)	602
Katurohini (S.)	181	Kesuria (B.)	505
Kauathodi (H.)	518	Kesuti (B.)	505, 672
Kaugach (H.)	421	Kevana (Bo.)	340, 510
Kaula (Bo.)	596	Kewan (Bo. & Mar.)	340
Kaumul (Simla)	289	Kewar (P. & Kash)	342
Kaumula (Simla)	290	Kewda (H.)	614
Kaundal (Bo.)	549	Kewda attar (H.)	634
Kaunteya (S.)	421	Keysuria (B.)	672
Kaura (H.)	342	Khadakatira (Guj.)	296
Kaureya (H.)	342	Khaderi (Bo.)	492, 661
Kauti (Bo.)	414	Khadira (S. & H.)	492, 603, 661
Kava (Bo.)	414	Khadiramu (Tel.)	492
Kavali (Bo.)	336, 597	Khadu (Bo.)	531
Kavdi (Bo. & M.)	535	Khair (H.)	492, 603, 661
Kaviang (Assam)	413	Khaira (Bo.)	661
Kaviri sandra (Tel.)	661	Khair champa (H. & Bo.)	598
Kavit (Bo.)	508	Khairuwa (U.P.)	664
Kavitha (H.)	508, 604	Khairwal (H.)	497
Kavu (Tel.)	597	Khaiulmalisa (Pers.)	388
Kavunnu (Mal.)	281	Khaiyar (Santh.)	661
Kawanch (H. & P.)	515, 605	Khajgoli-chavel (Bo.)	555
Kawar (P.)	342	Khajur (H., P., B. & Bo.)	519
Kawun (Bo.)	340	Khalis (S.)	538
Kayakuti (Bo.)	678	Khalse (B.)	538
Kayam (Tam.)	174	Khambhari (H.)	509
Kayaphul (H., B. & Sind.)	678	Khanam (P.)	312
Kayapute (Tam.)	598, 678	Khanda phag (Bushahr)	146
Kayaputi (H. & Bo.)	678	Khanghi (H.)	492
Kaya putia (Mal.)	678	Khanjana (S.)	536
Kayar (H.)	537	Khankshika (S.)	355
Kayasthika (S.)	355	Khapato (Sind.)	661
Kazanchik-kuru (Mal.)	499	Khappar kadu (Bo. & H.)	500, 604
Kazhangu (Mal.)	281	Khapura (S. & Bo.)	281, 297
Kazhar-shikkay (Tam.)	304	Kharakirasna (Bo.)	431, 689
Kazhichikay (Tam.)	499	Kharanarvel (Mar.)	389
Kazhua (Pers.)	327	Kharaparya (Mar.)	297
Kazuri (Goa)	680	Kharatua (P.)	103
Kela (H. & Bo.)	515, 598, 602	Kharbaq-hindi (Arab. & Pers.)	181
Keli (P.)	499	Kharbuza (P.)	309

Khaldi (Bo.)	596, 600	Khowlanjan (Arab.)	274
Kharebuz (Pers.)	493	Khubagi (Urdu)	598
Kharekhasak (Pers.)	430	Khubani (H.)	547
Khare-mughilan (Pers.)	661	Khubasi (H. & Bo.)	598
Khareti (H.)	409	Khubazi (H. & Bo.)	605
Khare-vazhun (Pers.)	662	Khubkallana (H.)	604
Khargee (S.)	538	Khulakhudi (H.)	352, 668
Khargosh (B.)	536	Khulanjan (Arab.)	274
Kharjramu (Tel.)	519	Khulanjanekabir (Arab.)	274
Kharjuri (S.)	519	Khulanjaneqasbi (Arab.)	274
Khark (Pers.)	306	Khumb (H. & Khumbi.)	655
Kharmor (H.)	523	Khurasani ajvayan (H.)	189, 190
Kharpara (S.)	533	Khurduwara (Pers.)	274
Kharwat (Bo. & Mar.)	279	Khursa (H.)	521, 590
Khar-zahrah (Vern.)	568	Khus (H.)	630, 631
Khas (Mar.)	597	Khushin (P.)	367
Khasak (Arab.)	430	Khushing (P.)	312
Khasake-kabir (Arab.)	681	Khusraveduruekalan (Pers.)	274
Khasake-kalan (Pers.)	681	Khussuck (Pers.)	430
Khash-khash (Pers.)	202, 205	Khwagawala (Pushtu)	684
Khash-khasharasa (Vern.)	205	Kiam (P.)	342
Khasia pine (Vern.)	223	Kibaheh (Pers. & Arab.)	224
Khaskhas (H.)	202	Kibrit (P.)	686
Khatsalio (Guj.)	523	Kichaka (S.)	287
Khawa (H.)	421	Kichakamu (Tel.)	288
Khawari (B.)	388	Kichilikihangu (Tam.)	327
Khawi (P.)	503	Kidamari (Bo.)	496, 664
Khaya (Burm.)	678	Kijapute (Tam.)	678
Khayahe-i-iblis (Pers.)	304	Kikar (H., Bo., B. & P.)	492, 595, 603, 661
Khayer (B.)	661	Kilati (S.)	287
Kher (Guj.)	661	Kilavari (Tam.)	665
Khesari (H. & B.)	546	Kilkaynelli (Tam.)	519
Khesari dal	541	Kilmora (Kumaon)	290
Khetpapra (S. & B.)	680	Kilmoru (Kumaon)	290
Khhapuram (Mal.)	281	Kils (Arab.)	666
Khilaf (Arab.)	684	Kimbika (S.)	314
Khinkari (Garhwal)	514	Kimri (Mal.)	270
Khinna (Vern.)	561	Kinbil (Arab.)	358
Khira (H. & B.)	502, 578	Kindal (Bo.)	602
Khiran (Bo.)	340	King-fisher (Eng.)	536
Khirni (H.)	601	Kingora (Dehra Dun)	290
Khiyar (Pers.)	354, 677	Kinjalka (S.)	402
Khoidai (Darjeeling)	413	Kinnab (Arab.)	84
Khoira (Assam)	661	Kino (H. & Eng.)	51, 301, 302
Khoiru (Uriya)	661	Kinro (Sind.)	684
Khokali (H. & Bo.)	595, 661	Kinsuka (S.)	301
Khokli (Mar.)	661	Kiraita (Bo.)	250
Khol-i-koknar (H.)	204	Kiralu (P.)	577
Khor (Bo. & P.)	492, 675	Kiramaja (Bo.)	535
Khora (Afg.)	174	Kiramal (Bo. & H.)	388
Khorasani ajowan (B.)	189, 190	Kiramaniowa (Bo.)	65
Khorasani-owa (Bo.)	190	Kiramar (H.)	496, 577, 664
Khoskadumar (Assam)	508	Kirambu (Tam.)	172
Khour (Nep.)	603	Kiramugam (Tam.)	281

Kiraruga (M.)	.....	547	Kokhuri (P.)	.....	367
Kirata (S.)	.....	278	Kokil (B.)	.....	535
Kirata-tikta (S.)	.....	250	Kokila (S.)	.....	535
Kirikodasige (Kan.)	.....	530	Kokilaksha (S.)	.....	353, 665
Kiriti (S.)	.....	438	Kokilanayana (S.)	.....	353
Kiriwolla (Sing.)	.....	605	Kokilphul (B.)	.....	425
Kiriyati (Guj.)	.....	278	Koknar (H.)	.....	204
Kiriyattu (Mal.)	.....	278	Kola (Vern.)	.....	81
Kirmala (H.)	.....	65	Kolaka (S.)	.....	270
Kirra (P.)	.....	126	Kolakanda (S.)	.....	251
Kirtanuphala (S.)	.....	306	Kolama (Tam.)	.....	524
Kirumikkundram (Tam.)	.....	313	Kolamavu (Tam.)	.....	601
Kiryat (H.)	.....	278, 603	Kola nut (Eng.)	.....	80
Kiryata (Guj.)	.....	278	Kolapoka (Tel.)	.....	281
Kislikuparva (S.)	.....	287	Kolaponna (Tel.)	.....	529
Kishtburkisha (Pers.)	.....	340	Kolhal (Bo.)	.....	604
Kissie (Nep.)	.....	290	Kolichechutar (Bo.)	.....	598
Kista (Pers.)	.....	336	Kolinjan (Guj.)	.....	274
Kitchli (Tam.)	.....	660	Kolista (Konkani)	.....	353
Kitra (Panj.)	.....	697	Kolkaphul (B.)	.....	425
Kiwach (H.)	.....	559	Kolliyam (Tam.)	.....	388
Kiyasa noin (Burm.)	.....	671	Kollu (Tam.)	.....	505
Kizh-kkayinelli (Mal.)	.....	519	Kolsunda (Bo.)	.....	353, 665
Klitakkam (Mal.)	.....	260	Kolumbu (Tam.)	.....	605
Koa (P.)	.....	687	Kombuppudalai (Tam.)	.....	528
Koaya (Tam.)	.....	683	Kombu-pudalai (M. & Tam.)	.....	549, 688
Kobusi (Nep.)	.....	678	Kommupotla (Tel.)	.....	528, 688
Kobutar (H.)	.....	535	Konch Bak (B.)	.....	534
Kochelachi-pullu (M.)	.....	599	Kondachani (Tam.)	.....	431
Kodaga (Tel.)	.....	342	Kondakahinda (Tel.)	.....	428
Kodagam (Tam.)	.....	431	Kondapala (M.)	.....	581
Kodali (M.)	.....	546	Konea-dumbar (H.)	.....	508
Kodapalai (Tam.)	.....	510	Konpal (H.)	.....	507
Kodapalla (Mal.)	.....	510	Kontedhotra (Mar.)	.....	283
Kodgasalai (Tam.)	.....	523	Koolthee (H. & Bo.)	.....	505
Kodippalai (Tam.)	.....	333	Kor (Kash.)	.....	342
Koditige (Tel.)	.....	494	Kora (H.)	.....	342
Kodiyagundal (Tam.)	.....	329	Korai (Tam.)	.....	672
Kodo (H.)	.....	547	Koraja (S.)	.....	274
Kodoa-dhan (B.)	.....	547	Koranti (M.)	.....	599
Kodra (Bo.)	.....	547	Korattai (M.)	.....	549
Kodrava (S.)	.....	547	Koricchira (Mal.)	.....	521
Kodukki (M. & Tel.)	.....	545	Korphad (Mar.)	.....	61
Koeva (P.)	.....	342	Kosam (Bo.)	.....	524, 581
Kogar (P.)	.....	342	Koshataki (S.)	.....	354, 513, 546, 598
Kogilam (Tam.)	.....	336	Koshnaha (Pers.)	.....	402
Kohala (Bo.)	.....	497	Koshtkulinjan (Mar.)	.....	274
Kohee bhang (H.)	.....	189	Kosom (Bo.)	.....	599
Kohoranj (M.P.)	.....	667	Kostum (Tam.)	.....	402
Koil (H.)	.....	535	Kosum (H.)	.....	524, 581, 599
Koiral (P.)	.....	497	Kosundra (P.)	.....	497, 595
Kokam (H. & Bo.)	.....	508, 674	Kot (H. & P.)	.....	402
Kokam chatel (Bo.)	.....	674	Kotakappala (Mal.)	.....	530
Kokam-ka-tel (H.)	.....	674	Kotamalli (Tam.)	.....	670

Kotapala (Mal.)	.....	276	Kuay (Gond)	.....	395
Kotapuli (Mal.)	.....	497	Kuberakam (Mal.)	.....	311
Kota-shavukku (Tam.)	.....	687	Kuberakshi (S.)	.....	304, 499, 596
Koti (Mal.)	.....	414	Kuchar (Vern.)	.....	146
Kotimiri (Tel.)	.....	670	Kuchela (S.)	.....	320
Koto (Assam)	.....	287	Kuchila (B.)	.....	248
Kottakka (M.)	.....	602	Kuchila-lata (H. & B.)	.....	599
Kottakkarandai (Tam.)	.....	525	Kuchla (H.)	.....	248
Kottani (Tam.)	.....	530	Kudaka (Bo.)	.....	311
Kotu (H.)	.....	557	Kudal churiki (Mal.)	.....	339
Kour (Kash.)	.....	181	Kudasapalai (Tam.)	.....	333
Koushikana (S.)	.....	285	Kudchampa (Mar.)	.....	514
Kova (Mal.)	.....	314	Kuddia-khar (Bo.)	.....	685
Kovai (Tam.)	.....	314	Kudurujivi (Tel.)	.....	522
Kovidara (S.)	.....	595, 600	Kuer (N.W.P.)	.....	342
Kow (C.P.)	.....	421	Kugagam (Tam.)	.....	281
Kowa (Bo. & H.)	.....	421	Kuhili (Bo.)	.....	515, 559
Kowah (C.P.)	.....	421	Kuilirakha (Utkal)	.....	353
Kowti (Mar. & Bo.)	.....	414, 415	Kukarchita (B.)	.....	601
Koyaputis (H. & Bo.)	.....	598	Kukarlata (H.)	.....	546
Koyya (Tam. & Mal.)	.....	521	Kukarvel (Bo.)	.....	598
Kpiththa (S.)	.....	604	Kukarwele (Bo.)	.....	546
Krakara (S.)	.....	537	Kukha-avalu (Tel.)	.....	669
Kramuka (S.)	.....	281	Kukkapala (Tel.)	.....	431, 689
Kramukam (Mal.)	.....	281	Kukkatulasi (Tel.)	.....	516
Kramukamu (Tel.)	.....	281	Kukkuta (S.)	.....	296
Krauncha (S.)	.....	534	Kuknar (Pers.)	.....	204, 207
Krishi (Kash.)	.....	697	Kukronda (P.)	.....	544
Krishnabija (S.)	.....	511	Kukseem (B.)	.....	602
Krishnachudika (S.)	.....	261	Kukurbicha (H.)	.....	602
Krishnachura (B.)	.....	602	Kukurchita (B.)	.....	677
Krishnajiraka (S.)	.....	516, 680	Kukursunga (B.)	.....	602
Krishna kamal (Mar.)	.....	516	Kul (B.)	.....	602
Krishnakhya (S.)	.....	297	Kulahaka (S.)	.....	353
Krishna lavana (S.)	.....	532	Kulahala (S.)	.....	604
Krishnamritrika (S.)	.....	531	Kulaka (B.)	.....	353
Krishna-parpati (H.)	.....	450	Kulanja (S.)	.....	274
Krishnasarathi (S.)	.....	421	Kulanjan (H., B. & Urdu)	.....	274
Krishnatel (H.)	.....	684	Kulanjana (S.)	.....	274
Krishna-til (Bo. & Vern.)	.....	569, 684	Kulatha kalai (H. & Vern.)	.....	446, 454, 461
Krishna-tulsi (Mal.)	.....	680	Kulattha (S.)	.....	311, 505, 597
Krishnavartma (S.)	.....	386	Kulf (Arab.)	.....	669
Kritawedhana (S.)	.....	354	Kulfa (H.)	.....	521
Krumbal (P.)	.....	674	Kuliakhara (B.)	.....	353, 665
Krunda (Afg.)	.....	430	Kuligam (Tam.)	.....	357
Krura (S.)	.....	297	Kulingi (S.)	.....	377
Kshapa (S.)	.....	325	Kulinjan (B. & H.)	.....	274, 494
Kshira (S.)	.....	355	Kulisam (Tam.)	.....	357
Kshiradala (S.)	.....	306	Kuljud (H.)	.....	543
Kshiraparni (S.)	.....	306	Kulla ravi (Tel.)	.....	674
Kshudrapatri (S.)	.....	262	Kulmasha (S.)	.....	311
Kshura (S.)	.....	353	Kulnar (H.)	.....	532
Kua (Tam.)	.....	600	Kulthi (H. & Bo.)	.....	505, 597
Kuar (H. & N.W.P.)	.....	342	Kuluaimungil (Tam.)	.....	288

Kumal (H.)	259	Kuravaram (Tam.)	431
Kumari (Mal.)	61	Kurchi (B. & Eng.)	22, 37, 51, 342, 346, 347, 383, 414
Kumarpathu (Guj.)	61	Kurfah (Bo.)	521, 599
Kumbal (P.)	508, 597	Kuri (P.)	438
Kumbhakarini (S.)	311	Kurinja (Tam.)	333, 431
Kumbhar (H.)	675	Kurka (Tel.)	688
Kumbhi (S., H. & B.)	499, 596	Kurkaru (S.)	596
Kumbhika (S.)	598	Kurkum (Arab.)	325
Kumbhira (S.)	535	Kurkurjiwah (H. & B.)	605
Kumbung (Vern.)	376	Kurne (Af.g.)	174
Kumhar (P.)	675	Kursingh (Bo.)	599
Kumila (P.)	358	Kurti-kakai (B.)	595
Kumiss (Eng.)	536	Kurtoli (Bo.)	598
Kumla (Bo. & Mar.)	671	Kuru (H. & B.)	181
Kumla nembu (H.)	669	Kurugu (Tam.)	508
Kumra (H.)	596	Kuruk (Mar. & Bo.)	311
Kumta (Rajasthan)	492	Kurukkum (Tam.)	283
Kumyss (Eng.)	536	Kurumulaka (Mal.)	520
Kunch (Mar. & B.)	260	Kurundu (Sing.)	126
Kunda (S.)	425	Kurumji (C.P.)	388
Kundali (S.)	500	Kuslmiz (Pers.)	670
Kund-phul (H.)	633	Kushtagandhini (S.)	436
Kundru (P.)	314	Kushtanasini (Vern.)	391
Kune-la-mon (Burm.)	662	Kushtia (S.)	402
Kungiligam (Tam.)	313	Kushtagandha (S.)	436
Kungiliyam (Tam.)	524	Kushtahantri (S.)	391
Kungku (H.)	173	Kusm (Kumaon)	524
Kungulu (Tam.)	501	Kust (P., H., Arab. & Pers.)	402
Kungumam (Tam.)	358	Kustabeheri (Arab.)	402
Kungumapu (Tam.)	323	Kustullhalu (Arab.)	402
Kungyi (H.)	409	Kusum (H. & B.)	596
Kuni (S.)	508	Kusumba (Bo.)	596
Kunjad (Pers.)	685	Kut (H., Guj. & Urdu)	402, 407
Kunjam (Tam.)	261	Kuta (S.)	386
Kunjar (Sind.)	274	Kuth (P. & B.)	402, 492
Kunjuram (Tam.)	261	Kuthika (S.)	402
Kunkuma (Tel.)	358	Kutki (B. & H.)	181
Kunkumapave (Tel.)	323	Kutri (P.)	493, 662
Kunni (Mal.)	260	Kutsita (S.)	402
Kunnikkuru (Mal.)	260	Kuttalkh (Pers.)	402
Kunrimani (Tam.)	261	Kuttra (H.)	598
Kupald (P.)	103	Kuvalam (Mal.)	267
Kupa-menya (Sing.)	661	Kuvangundal (Tam.)	313
Kupasi (P.)	340	Kuvilam (Tam.)	267
Kuppaimeni (Tam.)	595, 661	Kuzbarah (Arab.)	670
Kuppi (Tel.)	219	Kwai (Tam.)	314
Kur (B.)	402	Kwel (Mal.)	314
Kura (Bo., H., P. & N.W.P.)	342	Kweli (H.)	270
Kural (Tam.)	526	Kyakatwa (Burm.)	665
Kuramatukka (Mal.)	358	Kyoung-sha (Burm.)	681
Kuranelli (Tel.)	521		
Kurasaniyomam (Tam.)	190		
Kura-sanna (Bo.)	520	Laba (S.)	538
Kuravaka (S.)	677	Labangaphal (B.)	513

Lablab (H.)	.....	558	Langalika (S.)	.....	675
Labri (P.)	.....	261	Languli (H.)	.....	675
Labuwapetta (M.)	.....	538	Lanjai (H.)	.....	500
Lactus (Eng.)	....	536, 538	Lanka-marish (B.)	.....	667
Lada (Mal.)	.....	682	Lankasij (B.)	.....	507
Ladaki-revanda-chini (Bo.)	..	233	Lanu (Sing.)	.....	662
Ladana (H. & Bo.)	.....	538	Lappa (Tel.)	.....	356
Laftaf (Arab.)	....	667	Lard (Eng.)	.....	533
Lagargiwa (Hausa)	....	353	Larkimasa (H.)	.....	323
Laghududhika (S.)	..	507	Larkspur (Eng.)	.....	571
Laghukarni (S.)	.....	544	Lasan (Guj. & H.)	.....	271
Laghuparnika (S.)	.....	500	Lasanulaasafirulmurr (Arab.)	.....	342
Laghupatha (S.)	.....	320	Laser (Vern.)	.....	175
Lahan (Rajputana)	.....	428	Lashan (B.)	.....	271
Lahanagokhru (Bo.)	.....	528	Lashuna (S.)	.....	271
Lahanagokru (Bo.)	.....	430	Laskar (P.)	.....	579
Lahana-kalpa (Bo. & Mar.)	.....	528	Lasum (Mar. & B.)	.....	271
Lahauri hurmul (H.)	.....	368	Lasunas (Mar.)	.....	271
Lahore bachnab (Vern.)	....	54	Latakasturi (B.)	.....	391
Lahouri hurmud (P.)	.....	368	Lata-kasturikam (S.)	..	676
Lahtsan (H.)	.....	271	Latapalash (B.)	.....	303
Lahuriya (H.)	.....	601	Latapalasha (S.)	.....	303
Lai (Bo.)	.....	687	Lataphataki (B.)	.....	313
Lajalu (H. & Bo.)	.....	605	Lataphatkari (B.)	.....	607
Lajja (S.)	.....	605	Lathyrism (Eng.)	..	542
Lajward (H.)	.....	532	Latjira (H.)	..	493, 662
Lakh (Bo. & M.)	.....	538, 546	Latuwani (Assam)	.....	260
Laksha (S.)	.....	538	Lauha (S.)	.....	532
Lakshmi (S.)	.....	325	Lauha blasma (H.)	.....	445
Laktakarma (S.)	.....	413	Lauha sara (S.)	.....	446
Lalak (H.)	.....	305	Laung (H.)	..	172
Lalbachlu (H.)	.....	603	Lavana (S.)	.....	533
Lal barila (Vern.)	.....	409	Lavang (Bo.)	.....	172
Lalbherenda (B.)	.....	512	Lavanga (S. & B.)	.....	172
Lal bhopali (Bo.)	.....	503	Lavangalata (S.)	.....	355, 513
Lal bichua (H.)	.....	557	Lavangpatti (Kan.)	.....	126
Lalchandan (H.)	.....	522	Lavender (Eng.)	...	613, 638, 639
Lalchita (H. & B.)	.....	385	Lawa (H.)	.....	538
Lalchitarak (H.)	.....	385	Ledger bark (Eng.)	.....	113
Lal chitra (H., Bo. & Mar.)	.....	385	Lehsun (Urdu)	.....	271
Lal indrayan (H.)	.....	549	Lei (Bo.)	.....	687
Lalkara (Mar.)	.....	305	Lelka (H.)	.....	674
Lal madar (Mar. & H.)	.....	305	Lemon (Eng.)	.....	614, 625
Lalmeti (Mar.)	.....	511	Lemon ginger (Eng.)	.....	258
Lalmundajanvali (Mar.)	.....	519	Lemon grass (Eng.)	.....	50, 613, 630
Lalpost (H.)	.....	547	Lemon peel (Eng.)	.....	50
Lal rui (Mar.)	.....	305	Lemon tree (Eng.)	.....	130
Lalsabhuni (H.)	.....	528	Lemtam (Assam)	.....	414
Lalsag (H.)	.....	603	Lesser cardamom (Eng.)	.....	142
Lal siris (H.)	.....	600	Lichens (Eng.)	....	540, 642
Lambakarna (S.)	.....	270	Lilicha (Guj.)	.....	672
Lamjak (H. & P.)	.....	596	Lim (H.)	.....	311
Land snail (Eng.)	.....	533	Limbe (Kan.)	.....	130
Lanetsuru (Kash.)	.....	438	Lime (Eng.)	.....	614

Lime tree (Eng.)	....	130	Madar (H. & Vern.)	305, 306, 307, 555
Lingapotla (Tel.)	.....	528	Maddi-palu (Tel.)	..... 603
Lingur (Bo.)	....	689	Madgura (S.)	.... 535
Linseed (Eng.)	....	51, 542	Madha (H. & Bo.)	..... 636, 678
Liquorice (Eng.)	10, 51, 120, 177, 183, 184, 186, 261, 262		Madhashingi (H.)	.. . 336
Lisanulasufir (Bihar)	.....	342	Madhava (S.)	..... 356
Liverworts (Eng.)	....	540	Madhavi (S.)	.. . 597
Lizard (Eng.)	.....	537	Madhavilata (II. & B.)	.. . 597
Loahrapushpa (S.)	.....	356	Madhu (S. & B.)	.... 356, 536, 678
Lobelia (Eng.)	.....	33, 406	Madhuca (H.)	.... 513
Lochanahita (S.)	.....	311	Madhugam (Tam.)	..... 356, 357
Lodapathani (Urdu)	....	413	Madhujan (S.)	.... 668
Lodar (Guj.)	.....	413	Madhuka (S.)	.... 356, 357, 580
Lodduga (Tel.)	.....	413	Madhukam (Mal.)	.. . 260
Lodh (Mar., N.W.P., Bo., H. & Kumaon)	.. . 413, 414		Madhukamu (Tel.)	.. . 356
Lodhra (Mar.)	.....	413	Madhukarkati (S.)	.. . 500
Lodh tree (Eng.)	....	413	Madhumalati (S.)	.. . 333
Loha (H.)	....	532	Madhuparni (S.)	.. . 427
Lohaka (H.)	....	532	Madhuparnika (S.)	.... 427
Lohita (S.)	.....	297	Madhuphuttala (S.)	.... 356
Loli-sara (Kan.)	....	61	Madhura (S.)	.. . 355
Long (H.)	.....	172	Madhu riam (Assam)	.... 683
Lonia (H. & B.)	....	599	Madhurika (S.)	.. . 176, 498
Lonika (S.)	....	521, 599	Madhurnakamu (Tel.)	.... 309
Lotak (P.)	.....	430	Madhuyashiti (S.)	.. . 183
Lotus (Eng.)	.....	614	Maduragam (Tam.)	..... 261, 357
Louna (H.)	.....	577	Magadhi (S., Kan. & Tel.)	..... 511, 601
Loxa bark (Eng.)	.....	112	Magalingam (Tel.)	.. . 502
Luban (M., B. & Bo.)	.....	526	Magar (P.)	.. . 665
Lud (B. & H.)	.....	311	Magarbans (II.)	.. . 287
Luhuriya (H.)	.....	379	Magillam (Tam.)	.. . 514
Lukmuna (H.)	.....	72	Magiya-main (Bo.)	.. . 687
Lun (Burm.)	.....	680	Magrabu (H.)	.... 187
Lusoon (Bo.)	.....	271	Magur (B.)	.. . 535
Luvunga (Eng.)	.....	513	Maha (Mar.)	.... 356
Maajun (Vern.)	.....	89	Mahabala (II.)	.... 409
Macch ranga (B.)	.....	536	Mahabharavacha (S.)	.... 274
Mace (Eng.)	.....	200, 201	Mahadruma (S.)	.... 356
Machakai (Tam.)	.....	683	Mahakala (S.)	.. . 549
Machchi (H.)	.....	537	Mahakanda (S.)	.. . 271
Mach-chi-ka-tel (H.)	.....	674	Mahalimbo (C.P.)	..... 363
Macher tel (B.)	.....	674	Mahalimbu (II.)	..... 311
Machhika-siras (H.)	.....	533	Mahanim (S., II., Bo., B. & C.P.)	311, 312, 363
Machipatri (Tam. & Tel.)	....	72, 496	Mahanimb (H.)	..... 363
Machni (H.)	.....	546	Mahanimba (S.)	..... 493, 603
Madagirvembu (Tam.)	.....	312	Mahanimbu (B. & H.)	..... 500
Madalai (Tam.)	.....	522	Mahanjasi (S.)	..... 320
Madan (B. & H.)	.....	395	Maharukha (H. & Mar.)	..... 493, 595
Madana (S.)	.....	599	Mahasugandha (S.)	..... 397
Madananaba (Tel.)	.....	309	Mahatita (H. & B.)	.... 278
Mad apple (Eng.)	.....	134	Mahaushadhi (S.)	..... 352
			Mahaushana (S.)	..... 271
			Mahendravaruni (S.)	..... 128

Mahin (P.)	----	----	687	Maldoda (P.)	----	----	512, 597
Mahish (B.)	----	----	534	Male fern (Eng.)	----	----	649
Mahisha (S.)	----	----	534	Mali (Tam.)	----	----	312
Mahmira (Sind.)	----	----	392	Malkangni (B. & Bo.)	----	----	313
Mahori (P.)	----	----	686	Malkangoni (Mar.)	----	----	313
Mahua (H., B. & Bo.)	----	----	356, 601	Malkanguni (Tel. & Urdu)	----	----	313
Ma huang (Chinese)	----	----	8, 144	Mallagam (Tam.)	----	----	313
Mahua tree (Eng.)	----	----	356	Mallica (Vern.)	----	----	633
Mahuda (Guj.)	----	----	356, 357	Malligai (Tam.)	----	----	512
Mahula (H. & B.)	----	----	356	Mallika (S.)	----	----	512, 597
Mahura (Guj.)	----	----	356	Malt extract (Eng.)	----	----	26
Mahuva (Urdu)	----	----	356	Maluramu (Tel.)	----	----	267
Mahwa (H., B., Mar. & Bo.)	----	----	356, 580	Malwa opium (Eng.)	----	----	207, 212
Maidah (H.)	----	----	684	Mamaram (Tam.)	----	----	513
Maida-lakri (Bo.)	----	----	677	Mambulichi (Tam.)	----	----	525
Maida-lakti (Tam.)	----	----	677	Mamidiallam (Tel.)	----	----	503
Maiden-hair-fern (Eng.)	----	----	662	Mamira (H. & P.)	----	----	292, 424
Maiden-hair tree (Eng.)	----	----	558	Mamiran (H. & Bo.)	----	----	292, 424
Mail (M.)	----	----	537	Mami-ranchini (Pers. & Arab.)	----	----	424
Mailakkondei (Tam.)	----	----	648	Mamoli (P.)	----	----	686
Mai-nam (Tel.)	----	----	668	Mampuli (Mal.)	----	----	525
Mainphal (H., Urdu & Kumaon)	----	----	395, 599	Manaka (S.)	----	----	602
Maiphal (Bo.)	----	----	522, 683	Manashila (S.)	----	----	531
Mairsinga (Mar.)	----	----	667	Manattakkali (Tam. & H.)	----	----	525, 548, 685
Maitbrand (Kash.)	----	----	72	Manchineal tree (Eng.)	----	----	558
Maizali-gi (Burm.)	----	----	668	Manchinune (Tel.)	----	----	685
Majakani (Mal.)	----	----	683	Manchurian liquorice (Eng.)	----	----	186
Majdhab (Arab.)	----	----	497	Manda (M.)	----	----	604
Majuphal (S., H. & Bo.)	----	----	683	Mandalpatrika (S.)	----	----	297
Maka (Mar. & Bo.)	----	----	505, 672	Mandara (S., H., B. & Tel.)	----	----	306, 555, 595
Makal (H. & B.)	----	----	128, 549	Mandarai (M.)	----	----	497, 603
Makao (Bo.)	----	----	606	Mandarasu (Tam.)	----	----	306
Makaradhwaia (H.)	----	----	410, 449, 471	Mandari (Tam.)	----	----	497
Makheruna (Uriya)	----	----	353	Mandgay (Bo.)	----	----	578, 665
Mako (Bo. & P.)	----	----	525, 548, 599	Mandkolla (P.)	----	----	395
Makoi (H. & A.)	----	----	525, 548, 599, 685	Mandrake (Eng.)	----	----	226
Makusal (H.)	----	----	561	Manduka-bramha-kuraku (Tel.)	----	----	668
Malabaripankijar (Bo.)	----	----	274	Mandukaparni (S.)	----	----	321, 352, 668
Malabar nut tree (Eng.)	----	----	264	Manduki (S.)	----	----	321, 341
Malaiembu (Tam.)	----	----	363	Mandura (H.)	----	----	446
Malaiveppam (Tam.)	----	----	363	Manduram (S.)	----	----	532
Malaiyamnanaku (Tam.)	----	----	597	Maneru (Tel.)	----	----	313
Malakatbeng (Burm.)	----	----	683	Mangai inji (Tam.)	----	----	503
Malakoni (Kumaon)	----	----	313	Mangal (Tam.)	----	----	665
Ma-la-mai (Burm.)	----	----	667	Mangalappala (Mal.)	----	----	276
Malangni (Kumaon)	----	----	313	Mangalaprada (S.)	----	----	325
Malankara (Mal.)	----	----	597	Mangalyakusuma (S.)	----	----	438
Malati (S., H., B. & Tel.)	----	----	595, 633	Mangastin (Bo.)	----	----	674
Mala-vala (Mar.)	----	----	681	Mangustan (H., B. & Bo.)	----	----	604, 674
Malaveppu (Mal.)	----	----	311	Manimuni (Assam)	----	----	351
Malavinashini (S.)	----	----	438	Manja kadamba (Tam. & Mal.)	----	----	576, 595
Malavirimji (Mal.)	----	----	263	Manjal (Tam.)	----	----	325
Malavirinni (Mal.)	----	----	263	Manjalalari (M.)	----	----	425
Malbans (H.)	----	----	287	Manjalkodi (Tam.)	----	----	293

Manjana (Mal.)	.....	358	Marorphali (P., H. & Urdu)	.....	340, 510
Manjetti (Mal.)	.....	523	Marosi (H.)	.....	340
Manjishtatige (Tel.)	.....	523	Maroti (Mal.)	.....	414
Manjistha (S. & B.)	523, 599, 606		Marru (Tam.)	.....	513
Manjit (Bo.)	.....	599, 606	Marsada boli (Mysore)	..	667
Manjith (H.)	.....	606	Marsh crowfoot (Eng.)	....	560
Manjitti (Tam.)	.....	523	Marten (Eng.)	..	405
Mankachu (B.)	..	662	Martz (Kash.)	....	682
Mankand (Bo.)	..	596	Maru (S.)	..	513
Mankanda (H.)	..	662	Marudam (Tam.)	..	515
Mannal (Mal.)	..	325	Marudampattai (Tam.)	....	678
Mannanatti (Mal.)	..	514	Marudu (Tam.)	....	421
Mannapu (Mal.)	..	516	Marukmchuram (Mal.)	..	495
Manneal (H.)	..	395	Marulamatangui (Tel.)	..	438
Mansala (S.)	.....	521	Marulutige (Tel.)	....	438
Mansasij (B.)	507, 556, 597, 675		Maruppu (Tam.)	....	255
Manskhel (Kash.)	..	655	Maruta (Mal.)	..	515
Mantankattiri (Mal.)	....	525	Marutamotli (Mal.)	..	678
Manucha (Bo.)	..	673	Marwan (P.)	..	680
Manupasupu (Tel.)	..	293	Mash (P.)	..	519
Manya (S.)	.....	600, 606	Mashia (S.)	..	519, 598
Manyul (Kumaon)	.....	395	Mashia-parni (S.)	..	601
Maradarisina (Mal.)	....	280	Mashibatturi (Tam.)	..	466
Maralingam (Tam.)	..	502, 678	Mashikkay (M.)	..	522
Maramanjai (Mal. & Tam.)	259, 293		Mashikalai (B.)	..	519
Maramannal (Mal.)	..	293	Mashparui (H.)	..	601
Maranallari (Tam.)	..	270	Mashitul-glioul (Arab.)	..	601
Maraphali (H.)	..	340	Masi (Garhwal)	..	515, 598
Marathe-padwall (P.)	..	226	Masina (B.)	..	512
Maravara tsjembu (M.)	.....	510	Maskara (S.)	..	287
Maravattai (Tam.)	....	414	Maskaramu (Tel.)	..	288
Maravetti (Mal.)	....	414	Masolicha-tela (Bo.)	..	674
Maravuli (M.)	.....	547	Masukkaram (Tam.)	..	288
Maravuri (Tam.)	....	279	Masur (H. & S.)	....	597, 605
March (Afg.)	.....	682	Masuri (B.)	....	597, 605
Marchu (Guj.)	.....	667	Mat (Santh.)	..	665
Marchula (H.)	..	605	Matazor (H.)	....	547
Maredu (Tel.)	..	267	Mate (Eng.)	....	80, 83
Margosa (Eng.)	.....	360, 363	Matekissic (Nep.)	..	290
Mari (Tel.)	.....	674	Mathan (Mal.)	....	503
Maricha (S.)	520, 598, 605, 673, 682		Mathana (S.)	....	389
Marichamu (Tel.)	.....	520	Matrisinhi (S.)	....	264
Marichi-phalam (S.)	..	667	Matsya (S.)	....	537
Mariguti (Mal.)	.....	339	Matta-pal-tige (Tel.)	....	676
Marihuana (Eng.)	....	89	Mattipongillyam (Mal.)	..	493
Marinalu (Mal.)	....	325	Mattisa (H. & P.)	..	667
Marinandai (P.)	.....	520	Mattisa-wangru (Kumaon)	....	667
Marisha (S.)	.....	603	Mattukumittukoni (Tel.)	....	431
Marithondi (Tam.)	.....	677	Mattutumatti (M.)	....	545
Marjara (S.)	.....	386	Maul (H. & B.)	.....	356
Marking-nut tree (Eng.)	.....	407	Maulsari (P. & U.P.)	....	514, 678
Marlumutta (Tam.)	.....	438	Maur (B.)	.....	537
Marmakoul (Simla)	.....	173	Maura (P.)	.....	689
Marmmari (S.)	.....	290	Mauri (B.)	.....	176, 219

Mavagam (Tam.)	.....	..	357	Mica (Eng.)	.....	.....	532
Mavilavu (Mal.)	.....	..	267	Migraine (Eng.)	.....	.....	212
Mavillangai (Tam.)	.....	..	267	Milagay (Tam.)	.....	.....	667
Mawa (P.)	.....	..	689	Milagu (Tam.)	.....	.....	520, 682
May apple (Eng.)	.....	..	226	Milkaranai (Tam.)	.....	.....	428
Mayil-tuttam (Tam.)	.....	..	671	Milkiisse (Nep.)	.....	.....	291
Mayilu-tuttam (Tel.)	.....	..	671	Mimbu (Burm.)	.....	.....	674
Mayirsikki (Tam.)	.....	..	648	Mimosa (Eng.)	.....	.....	618
Mayurashikha (S.)	.....	595, 648		Min (Guj.)	.....	.....	668
Mayurshikha (S.)	.....	493, 648		Minang (Vern. & Chinese)	.....	.....	203
Mayursikha (Bo.)	.....	393, 648		Mindhal (Mar.)	.....	.....	395
Mazri (H.)	.....	..	605	Mindla (P.)	.....	.....	395
Mazu (H. & Pers.)	.....	..	683	Mineral pitch (Eng.)	.....	.....	457
Meda (Tel.)	.....	..	677	Minguta (Bo.)	.....	507, 556, 673	
Medasak (P.)	.....	..	677	Minjurgorwa (H.)	.....	.....	435
Medashinge (B.)	.....	..	336	Minnari (Mal.)	.....	.....	388
Medhakrita (S.)	.....	..	296	Mint (Eng.)	.....	198, 199, 613, 639	
Medhu (Vern.)	.....	..	569	Minvajaram (M.)	.....	.....	533
Medhya (S.)	.....	..	438	Minyenney (Tam.)	.....	.....	674
Medi (Tel.)	.....	..	674	Mipanny (Sing.)	.....	.....	678
Medicinal cabbage tree (Eng.)	.....	..	280	Mirapa-singa (Tel.)	.....	.....	667
Mehaghlmi (S.)	.....	..	325	Mirch (H. & P.)	.....	544, 667	
Mehedi (B.)	.....	..	597	Mirchai (H. & B.)	.....	194	
Mehernanbarari (Pers.)	.....	..	436	Mirch-wangum (Kash.)	.....	667	
Mehndi (H. & P.)	.....	597, 677		Miri (Guj. & Bo.)	.....	682	
Meinkara (Nep.)	.....	..	428	Mirialu (Kan.)	.....	682	
Mellugu (M. & Tam.)	.....	535, 668		Miris (Sing.)	.....	667	
Melon tree (Eng.)	.....	..	309	Mirugusayidagam (Tam.)	.....	306	
Mena (Mar. & Kan.)	.....	..	668	Miruttusam (Tam.)	.....	288	
Menda (H.)	.....	..	677	Miryala (Kan.)	.....	682	
Mendel (Vern.)	.....	..	568	Mishmeeteta (Assam)	.....	292	
Mendha singi (Urdu)	.....	..	336	Mishmitita (H.)	.....	292	
Mendhi (S.)	.....	..	667	Mishmitita (Bo.)	.....	292	
Mendi (B. & Mar.)	.....	..	677	Mitazahar (Ind. Baz.)	.....	60	
Mengkop (Burm.)	.....	..	674	Mithabish (Ind. Baz.)	.....	60	
Mengut (Burm.)	.....	..	674	Mitha indarjou (H.)	.....	530, 606	
Menphal (B.)	.....	..	395	Mithakaddu (H.)	.....	503	
Menthulu (Tel.)	.....	..	528	Mitha limbu (H.)	.....	625	
Menthya (Kan.)	.....	..	528	Mitha-tel (H.)	.....	684	
Meradu (H.)	.....	..	547	Mithazahar (H.)	.....	54	
Meral (Santh.)	.....	..	673	Mitti attar (Vern.)	.....	634	
Merasingi (H.)	.....	..	597	Mochkand (H.)	.....	672	
Mesh (B.)	.....	..	537	Modikka (Tel.)	.....	595	
Mesha (S.)	.....	..	537	Mogadam (Tam.)	.....	678	
Mesharingi (S.)	.....	..	336	Mogalieranda (Bo.)	.....	676	
Meshasingi (H. & B.)	.....	..	336	Mogra (B.)	.....	512	
Mestapat (B.)	.....	..	510	Mogri (B.)	.....	512	
Methi (S., H., P. & Bo.)	.....	528, 582		Moha (H., Bo. & Dec.)	.....	356, 357	
Mewri (H.)	.....	..	689	Mohachajhada (Mar.)	.....	357	
Mexican poppy (Eng.)	.....	..	283	Mohi (Bo.)	.....	357	
Mexican tea (Eng.)	.....	..	100	Moho (Mar.)	.....	356	
Mexican wonder-flower (Eng.)	.....	..	466	Mohra (Bashahr)	.....	56	
Mhach (Kash.)	.....	..	678	Mohri (Kash. & Vern.)	.....	63, 56	
Mhowra (Mar.)	.....	..	356	Mohua (H.)	.....	357, 580	

Mohuva (B. & Vern.)	357, 580	Mudaima (Tam.)	498
Mohwa (Mar., Bo. & Kumaon)	356, 357	Mudhar (H.)	305
Mokkavepa (Tel.)	518	Muduru-tulla (Sing.)	680
Mom (H., B., Dec. & Pers.)	535, 668	Mudusveduru (Tel.)	288
Momadru chopandiga (Kash.)	661	Mugani (H. & B.)	601
Momia (Arab. & Pers.)	457	Mugra (H.)	597
Monkey-face tree (Eng.)	358	Muhli (C.P.)	363
Monkey nut (Eng.)	63	Mukaratte (Tam.)	297
Moonwort (Eng.)	603	Mukhajali (H.)	515
Moql (Arab.)	285	Mukkampala (Mal.)	276
Mor (Bo.)	537	Mukkanbalai (Tam.)	276
Mora (Mar.)	356	Mukkopecera (S.)	598
Morang elaichi (H. & B.)	144	Mukta (S.)	537
Moravela (Bo.)	500, 544	Muktajuri (B.)	661
Moriel (Bo.)	500	Mukul (B.)	285
Moriya (N.W.P.)	342	Mukurattai (Tam.)	297
Morpankhi (H.)	493	Mula (B. & Bo.)	522
Morphankhi (H.)	648	Mulagu (Mal.)	682
Morunda (Garhwal)	660	Mulaka (S.)	522
Morwa (Bo.)	601	Mulanippalvirai (Tam.)	311
Mosaic gold (Eng.)	533	Mulappumarutu (Mal.)	524
Mosses (Eng.)	540	Muleti (P.)	183
Motapati (H.)	512	Mulhatti (H.)	183
Moth (H. & P.)	601	Muli (H. & P.)	522
Motha (Guj.)	672	Mulim (P.)	675
Mothan gokgaru (Guj.)	681	Mullangi (Tam., Tel. & Mal.)	522
Mothie-gokharu (Mar.)	681	Mullanjakka (Mal.)	603
Mothi-kuhili (Bo.)	559	Mullu-chitta (Tam.)	603
Moti (H. & Bo.)	537	Mullukala (Tam.)	289
Motia (H.)	512, 597	Mullumungil (Tam.)	288
Moto satodo (Guj.)	297	Mullusevantige (Kan.)	523
Motte (M.)	536	Mulluvellari (M.)	578
Mottoghokru (Bo.)	518	Mulmulam pattil (Mal.)	287
Motulimbu (Guj.)	130	Multaumati (P.)	532
Moulds (Eng.)	540	Mulugu (Tel.)	514
Moulmein (Eng.)	311	Mum (Bo.)	535
Mouse (Eng.)	536	Mundam (Vern.)	446
Mouz (Pers. & Arab.)	678	Mundgay (Bo.)	287
Mova (Bo.)	356	Mundi (H.)	525
Movanujhada (Guj.)	357	Mundirika (S.)	525, 601
Mowa (H.)	356	Mundiri-kai (M.)	577
Mowda (Mar.)	356	Mundul (Tam.)	288
Moydi (Tel.)	674	Munemal (Sing.)	678
Mriganabhi (S.)	465	Mungas kajur (H.)	548
Mrigashinga (S.)	340, 510	Mungil (M.)	578
Mrigasringa (S.)	535	Mung-phali (H.)	63
Mrigendrani (S.)	264	Mungusavel (Mar.)	397
Mrityubija (S.)	287	Munichhada (S.)	276
Mubarak (Bo.)	648	Muniganga ravi (Tel.)	688
Mubaraka (H. & Kumaon)	662	Munigha (Uriya)	364
Muchchugoni (Kan.)	528	Munjariki (S.)	517, 605, 680
Muchukunda (S., H. & B.)	395, 599	Munna (Mal.)	389, 521
Muda (Mar.)	305	Munnai (Tam.)	389, 521
Muda-cottan (Tam.)	667	Munna-takali-pullum (Tam.)	685

Munnay (Tam.)	683	Naga (Tam.)	686
Mur (H.)	537	Nagabala (S.)	606
Muradsing (Mar.)	340	Nagabala (H.)	409
Murba (B.)	601	Nagadamani (S.)	496, 596
Murdasing (Guj.)	340	Naga-danti (M.)	543
Murdosing (H.)	532	Nagadona (B. & Bo.)	496
Murga (H.)	612	Nagadouna (H.)	496
Murgal (Tam.)	508	Nagagandha (S.)	397
Murgalmara (Tam.)	674	Nagala-dudheli (Guj.)	681
Murhari (H.)	500	Nagala dudhi (Guj.)	330
Murmuria (B.)	525	Nagamushti (M.)	599
Murr (Arab.)	670	Nagappu (Tam.)	518
Murru (B.)	513	Nagaranga (S.)	609
Murukkan (Tam.)	301	Nagar motha (H. & B.)	604
Murunga (Sing.)	364	Nagar mustaka (S.)	604
Murwa (H. & Dec.)	513	Nagavalli (S. & Mal.)	371
Murwo (Bo.)	513	Nagavallika (S.)	371
Musabbar (H.)	61, 62	Nagbail (H.)	435
Musakani (H.)	511	Nagchampa (Bo. & Mar.)	667
Musali (S.)	537	Nag-dowan (Bo.)	544
Mush (H.)	536	Nagini (S.)	371
Mushakarni (S.)	511	Nagkaria (Bo.)	675
Mushak-dana (B.)	676	Nagkeshar (S., H. & B.)	605
Mushali (S.)	671	Nagdona (H. & B.)	72
Mushika (S.)	536	Nagphana (H. & B.)	598
Mushk-bhendi-ke-bij (Bo.)	676	Nagpheni (H.)	435
Mushk-dana (H. & Pers.)	676	Nagura (Tel.)	389
Mushkiara (P.)	548	Naguttam (Tam.)	388
Mushrooms (Eng.)	540, 652, 655, 656, 657	Nahani (H. & B.)	253
Musk (Eng.)	372, 450, 465	Nahani khapat (Bo.)	603
Musk-deer (Eng.)	465, 536	Naharu (Assam)	271
Musk-duck (Eng.)	465	Nahi-kuddaghu (Tam.)	600
Musk-ox (Eng.)	465	Nai (H. & Pers.)	287, 397, 605
Musna (H.)	548	Nainchavandi (Pers.)	278
Mussulkund (M.P.)	671	Nairuri (Tel.)	686
Musta (S. & Bo.)	604, 672	Naka-danti (Mal.)	497, 512
Mustard cake (Eng.)	542	Nak bel (Sind.)	297
Mustaru (H.)	597	Nakchhikni (H.)	333
Mutakku (Mal.)	595	Nakhala (Bo.)	533
Mutha (B. & H.)	604, 672	Nakharavha (S.)	425
Muthiva (Mal.)	505	Nakkchikni (H. & B.)	506
Mutra (S.)	538	Naktamala (S.)	388
Muttava (Tel.)	409	Nakuleshtha (S.)	284
Muudhkottan (M.)	544	Nakuli (S.)	274
Myetype (Burm.)	605	Nakulikanda (H.)	397
Myristica (Eng.)	200	Nal (B. & P.)	519
Myrobalam (Eng.)	52	Nala (S., H. & B.)	519, 559
Myrobalans (Eng.)	441, 446, 460, 688	Nalaveppu (Mal.)	278
Myrtle (Eng.)	613	Nali (S.)	510, 604
Nabhi-ankuri (Uriya)	685	Nalichi baji (Bo.)	546
Nach-churuppan (Tam.)	689	Nalikadal (S.)	300
Nadeyi (S.)	389	Nallaavalu (Tel.)	498
Nag (H.)	441	Nalla-jilakra (Tel.)	680
		Nallankolamu (Tel.)	270

Nalla-pompil (Mal.)	596	Nattilupai (Tam.)	357
Nallar (H. & B.)	669	Nattu-ati-vadayam (Tam.)	230
Nallatumba (Tel.)	492	Nattu-ireval-chinni (Tam.)	233
Nalla-vavili (Tel.)	689	Nattu-reval-chinni (Tel.)	233
Nal-lenny (Tam.)	685	Natu sengota (Tel.)	561
Nalleru (Tel.)	669	Nau-nau (Burm.)	670
Nalljilledu (Tel.)	306	Nava (S.)	297
Nalluduga (Tel.)	270	Navagragandha (S.)	287
Nam-nam (Ceylon)	596	Naval (Tam.)	686
Namon (M.)	531	Navanga (S.)	377
Namuti (B.)	597	Navasagara (H.)	531
Nanabeeam (Tel.)	335	Navasagara (H.)	532
Nanal (Tam.)	523	Navasara (S.)	531
Nanda (S.)	312	Navya (S.)	297
Nandi (Tel.)	312	Nawar (Tam.)	686
Nandivriksha (S.)	312	Nayeti (Bo.)	507, 579
Nandivruksha (S.)	336	Nayibela (Kan.)	670
Nandru (P.)	547	Nayikadugu (Tam.)	321
Nanjamurich-chan (Tam.)	689	Nayivelai (Tam.)	321
Nanjunda (Tam.)	496	Na yop (Burm.)	667
Nankwhah (Pers.)	93	Nay-palai (Tam.)	230, 689
Nannana (Mal.)	523	Naytului (M.)	516
Nannari (Tam.)	187	Nayurivi (Tam.)	493, 662
Narang (Pers.)	669	Neem (Eng.)	360
Narangi (H. & Vern.)	624, 669	Neerugubbi (Tel.)	353
Naranj (Arab.)	669	Negalu (Kan.)	528
Naranjada bark (Eng.)	115	Negli (Bo.)	547
Narasala (H.)	559	Negro bean (Eng.)	559
Naraseja (Bo.)	556, 607	Neimal (H.)	686
Narasya (Mar.)	507	Nehar (Kumaon)	411
Narcha (B. & H.)	501, 596, 604	Nela-gadale (Kan.)	63
Narcissus (Eng.)	618	Nelaguli (Tel.)	673
Narel (Bo.)	600	Nela-gulimidi (Tel.)	673
Narendu (Tel.)	686	Nelajidi (Tel.)	497, 595
Nareyr (Tel.)	686	Nelakadal (Mal.)	63
Nargis (H. & P.)	547, 634	Nelamadu (Tel.)	527
Nargunda (Bo.)	689	Nelampala (Mal.)	597
Naringi (Bo.)	669	Nela-naregan (Mal.)	679
Narivalai (Tam.)	500	Nela-nekhare (Kan. & Tel.)	339
Nari-vengayam (Tam.)	251	Nelapalai (Mal.)	507
Narivila (Tam.)	508	Nela panna maravar (M.)	648
Nariyal (H.)	600	Nela tadi (Tel.)	671
Narkul (H.)	519	Nela-tangedu (Tel.)	98
Narra alagi (Tel.)	677	Nelatapire (Tel.)	431
Narvel (Tam. & Bo.)	389, 686	Nelatatygadda (Tel.)	503
Nasa (S.)	264	Nelavarike (Kan.)	98
Nasabhaga (B.)	519	Nclavemu (Tel.)	278
Nasodu (Tel.)	686	Nelavusari (Tel.)	519
Nata (B.)	499, 596	Nelli (Mal., Tam. & Tel.)	506, 673
Natakaranja (B.)	304, 499	Nelli-kai (Tam.)	673
Natangi (S.)	377	Nemali (Tel.)	511
Nat-ki-sana (Guj.)	98	Nemuka (B.)	320
Natram-takara (Mal.)	499	Nepal (Guj.)	671
Nattamtakara (Tam.)	499	Nepala (Tel.)	502

Nepal aconite (Eng.)	57, 60	Nimak (H.)	533
Nepalam (Tel.)	677	Nimb (H.)	360
Nepala-vitua (Tel.)	671	Nimba (S.)	360
Nepal camphor wood (Eng.)	125	Nimbaka (S.)	363
Nepal musk (Eng.)	470	Nimbe (Kan.)	130
Nepa-naringu (Kan.)	679	Nimgachh (B.)	360
Ner (P.)	411	Nimgilo (B.)	426
Neremulli (Tam.)	353	Nimilahara (Nep.)	412
Neringil (Mal.)	430, 528	Nimma (Tel.)	130
Nerinnil (Mal.)	430	Nimmagaddi (Tel.)	503
Neriyurishippal (Tam.)	494	Nimrudi (Bo.)	602
Nerunji (Tam.)	528	Ningur (C.P.)	358
Nervalam (Tam., Mal. & M.)	502, 578	Niradhar (P.)	329
Nervalum (Tam.)	671	Niradi (Tel.)	414
Nerwar (Nep.)	173	Niradimuttu (Tam.)	414, 497
Nettavil (Mal. & Tam.)	279	Niraidarudian (Tan.)	427
Nettil (Tam.)	288	Niralam (Mal.)	414
Nettilingam (M.)	521	Nirbash (Vern.)	226
Newarang (Bo.)	673	Nirbisi (H.)	504
Newrang (Bo.)	557	Nir-brami (Tam.)	341
Neyarum (Mal.)	203	Nirdahana (S.)	408
Neyi (Tam. & Tel.)	675	Nirdishta (S.)	290
Nidigdhika (S.)	686	Nirgandi (H.)	689
Nikumba (S.)	512	Nirgundi (S., Bo. & B.)	689
Nil (H. & B.)	597, 601	Nirgur (Bo.)	689
Nila (S. & Bo.)	297, 597	Nirguviveru (Tel.)	353, 605
Nilakant (P.)	509	Nirmali (H., P., B. & Bo.)	526, 686
Nila-nirgundi (S.)	605	Nirmalli (Tam.)	353, 605
Nilap-panaik-kizhangu (Tam.)	671	Nirmarudu (Tam.)	421
Nilappanaik-kilhangu (Tam.)	503	Nirmuli (Mar.)	503
Nilappuchani (Tam.)	511	Nirmulia-kashavela (Mar.)	329
Nilapunarnava (S.)	297	Nir-noch-chi (Tam.)	690
Nilapushpa (S.)	529	Nirnuchi (Mal.)	500
Nilatar (S.)	329	Nirpirimie (Tam.)	341
Nilathari (P.)	329, 503	Nirulli (Kan. & Tel.)	494, 662
Nila-thotha (H.)	531	Nirumel neruppu (M.)	543
Nila-tuta (H.)	671	Niruvate (Kan.)	301
Nila-vaka (Mal.)	98	Niru-vavili (Tel.)	690
Nilavalutina (Mal.)	524	Nirvala (Kan. & Mal.)	671
Nilavarshabhu (S.)	297	Nirvetti (Mal.)	414
Nilavembu (Tam.)	250, 278	Nirvisha (S.)	504
Nila virai (Tam.)	98	Nishinda (B.)	689
Nili (Tam.)	595	Nishotar (Bo.)	194, 517
Nilika (S.)	601	Nisinda (H. & Bo.)	689
Nili-nargandi (H.)	605	Nisot (P.)	517
Nilini (S.)	297	Nisothe (H.)	194, 517
Nilkamal (H.)	516	Nitikulava (Tel.)	516
Nilkant (P.)	181	Nivadunga (Bo.)	673
Nilkantha (S.)	537	Nochchi (Tam.)	689
Nilkattei (H. & P.)	545	Nohanoakdo (Guj.)	305
Nilotpala (S.)	516	Nona (P.)	577
Nil-sapla (B.)	516	Nullajilakara (Tel.)	516
Nilufer (Arab. & Pers.)	679	Nulle rutigeh (Tel.)	669
Nim (H., P., B. & Bo.)	51, 360, 363, 364	Nurah (Pers.)	666

Nurma (H.)	.....	509, 600	Pachampacha (S.)	.....	290
Nutmeg (Eng.)	.....	51, 200, 201, 372	Pachapat (B.)	.....	581
Nutmeg butter (Eng.)	.....	202	Pachiare (Tel.)	.....	497
Nuvvu (Tel.)	.....	685	Pachchaganeru (Tel.)	.....	425
Nuvvulu (Tel.)	.....	685	Pacholi (H.)	.....	581
Oandak (P.)	.....	544	Packur-mul (B.)	.....	560
Obal (P.)	.....	557	Padal (Bo.)	.....	526
Oda (Uriya)	.....	255	Padalamulam (Tam.)	.....	427
Officinal leadwort (Eng.)	.....	385	Padam (Uriya)	.....	679
Oibanum (Eng.)	.....	615	Padavala (Kan.)	.....	528
Ol (B.)	.....	494	Paddam (H. & Kumaon)	.....	521, 547
Olancha (Mar.)	.....	672	Padebiri (Nep.)	.....	681
Olatkambol (Bo. & B.)	.....	259	Padelon (H.)	.....	532
Oleander (Eng.)	.....	40, 41	Pader (H.)	.....	526
Olenkirayat (Mar.)	.....	278	Padhai (Bo.)	.....	287
Olikiriyata (Guj.)	.....	278	Padma (B.)	.....	679
Omamu (Tel.)	.....	93	Padmaka (S. & Mar.)	.....	402, 521, 547
Oman (Tam.)	.....	93	Padmakasta (Bo.)	.....	521, 547
Onion (Eng.)	.....	614	Pagal-ka-dawa (H.)	.....	397
Onkla (Guj.)	.....	270	Pagoda tree (Eng.)	.....	569
Ooppootravagum (M.)	.....	531	Pahadmul (Bo.)	.....	320
Ophion (H.)	.....	205	Pahadvel (Bo.)	.....	320
Opium (Eng.)	.....	19, 26, 34, 51, 90, 91, 120, 162, 166, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 294, 430	Paharicha (N.W.P.)	.....	367
Opium poppy (Eng.)	.....	202	Pahari gandana (H.)	.....	602
Oppulu (Tel.)	.....	281	Paharikaghzi (H.)	.....	130
Oppuvakkulu (Tel.)	.....	281	Paharinimbu (H.)	.....	130
Oriental cashew nut (Eng.)	.....	407	Paidi (Tel.)	.....	674
Orila (Mal.)	.....	529	Paillie (M.)	.....	537
Orjun (Assam)	.....	421	Paiman (H.)	.....	686
Orpiment (Eng.)	.....	454, 531, 532	Painaira-wel (Sing.)	.....	667
Orris (Eng.)	.....	403, 614	Painipasha (Mal.)	.....	689
Oru (Tam.)	.....	270	Painipishin (Tam.)	.....	689
Osai (Assam)	.....	435	Pakalam (S.)	.....	402
Osari (Bo.)	.....	603	Pakar (B.)	.....	508
Oschor (Arab.)	.....	305	Pakhanbed (H.)	.....	498, 595
Oshar (Arab.)	.....	305	Pakhanbhed (Guj.)	.....	181
Oshmor (Arab.)	.....	305	Pakka (Mal.)	.....	281
Ot (Santh.)	.....	655	Pakku (Tam.)	.....	281
Otdhompō (Santh.)	.....	508	Pakkupanai (Tam.)	.....	281
Othalam (Mal.)	.....	316	Pala (Mal.)	.....	276
Otigana (Guj.)	.....	296	Palah (Pers.)	.....	301
Otto (Eng.)	.....	239	Palai (Tam.)	.....	276
Ouplate (Bo.)	.....	402	Palagaruda (S. & Tel.)	.....	276
Owa (Bo.)	.....	93	Palak (P.)	.....	674
Owl (Eng.)	.....	534	Palakudai (Tam.)	.....	512
Oyster (Eng.)	.....	537	Palakura (Tel.)	.....	333
Pabda (B.)	.....	534	Palamodikku (Tel.)	.....	511
Pachaiyalari (Tam.)	.....	425	Palandam (Tam.)	.....	288
Pachak (B. & H.)	.....	402	Palandu (S.)	.....	494, 662
			Palas (H. & B.)	.....	301
			Palasa (S.)	.....	301, 302
			Palasavela (Bo. & Mar.)	.....	303
			Palasham (Tam.)	.....	301
			Palashaparni (S.)	.....	436

Palasi (Bo.)	303	Papacheli (S.)	320
Palas-kar-jhar (Bo.)	301	Papadkhar (Vern.)	532
Palas pipal (B.)	688	Papai (Bo.)	309
Palas piplo (Bo.)	688	Papar (H.)	173, 388
Palatige (Tel.)	333, 500, 512	Paparabudama (Tel.)	128
Paliakiri (Tam.)	681	Papaw tree (Eng.)	309
Palisa (Tam.)	509	Papaya (H., Mar. & Eng.)	50, 309
Palla (M.)	601	Papaya tree (Eng.)	300
Pallachinta (Tel.)	681	Paper (Kumaon)	388
Palleru (Tel.)	430, 528	Papeta (Eng.)	309
Pallerutiva (Tel.)	313	Papeya (B.)	309
Palmarosa (Eng.)	613	Paphri (P.)	388
Palmutakku (Mal.)	511	Papita (H.)	309
Palulavam (Mal.)	313	Papkakani (Kumaon)	313
Palupaghel kalung (M.)	601	Pappaiya (B.)	309
Palval (H.)	688	Papparappuli (Tam.)	493
Palvalli (Mal.)	511	Pappayam (Mal.)	309
Palwal (P.)	688	Papparamulli (Tam.)	524
Pama (P.)	195	Pappukura (Tel.)	102, 521, 669
Pambalimasu (Tam.)	500	Papra (H. & Pushtu)	226, 674
Pampalamasam (Tel.)	500	Papri (H. & P.)	226, 511, 544
Pampana (Tel.)	681	Para (H.)	532
Pamparamasam (Mal.)	500	Parada (S.)	532
Pampi (Tel.)	325	Paradise apple (Eng.)	624
Pamukh (P.)	549	Paraguay tea (Eng.)	80, 81
Pan (H., B., Mar., Bo. & Urdu)	371, 372	Parampu (Mal.)	521
Pana (Mal. & Tam.)	666, 681	Paramutty (Tam.)	681
Panachi (Mal.)	505	Parangikayi (Tam.)	503
Panai (Tam.)	288, 498	Paras (Mar.)	301
Panasa (S. & Tel.)	496, 595	Parash (B.)	527
Pancha bala (H.)	409	Parasikaya (S.)	190, 545
Pancha mukhi (S.)	264	Paraspipal (H. & P.)	527, 597, 688
Pandharen-kamal (Bo.)	605	Paravatanghri (S.)	313
Pandharighentuti (Mar.)	297	Paravatapadi (S.)	313
Pandhrakura (Bo.)	342	Paravata-yanada (S.)	676
Pandolu (Bo.)	528	Parbata (S.)	534
Pandruk (Konkani)	525	Pares pipal (B.)	688
Paneermaya (H.)	537	Pari (H.)	320
Pangamol oil (Eng.)	388	Paribhadraka (S.)	402
Panibira (M.)	546	Parijani (S.)	290
Pani-ki-sanbhula (H.)	690	Paringay (M. & Tam.)	524, 685
Paniphal (B.)	599	Parisa (S.)	688
Paniri (Uriya)	664	Paris green (Eng.)	576
Panisamalu (B.)	690	Parisha (S.)	527
Panisoka (H.)	532	Parivai (Tam.)	427
Paniyarattutti (Tam.)	492	Parjaniya (S.)	290
Panjangusht (Pers.)	529	Parna (S.)	371
Panjiri-ka-pat (H.)	495	Parnai (Tam.)	651
Panjirikapatta (Dec.)	495	Paroa (H.)	674
Pankauri (B.)	537	Parpatha (S.)	523
Panmouri (B.)	176	Parpparam (Mal.)	518
Pannakilhanumavala (Mal.)	649	Parrot (Eng.)	537
Panna-maram (Tam.)	666	Parsachajhada (Bo.)	688
Panwar (P.)	677	Parsipu (H. & Bo.)	527, 688

Parsvapu (Tel.)	438	Patukurkka (Mal.)	495
Partridge (Eng.)	535	Patuvalli (Mal.)	320
Parupu kire (Tam.)	669	Paugli-mehandi (P.)	543
Parupukkirai (Tam.)	102	Paunippayaru (Tam.)	519
Parusha (S.)	509, 601	Pavala-malligai (Tam.)	516
Paruva (Mal.)	526	Pavamekkekeyi (Kan.)	128
Parval (H.)	528	Pavaneshta (S.)	363
Parvar (H.)	528, 549, 688	Pawal-chhata (B.)	656
Parvara (H.)	535	Pawpaw (Eng.)	309
Parvata (S.)	363	Payana (Mal.)	689
Pasalai (M.)	521	Payra (B.)	535
Pasamantram (Tam.)	293	Peacock (Eng.)	537
Pashanabheda (S.)	498, 603	Pea family (Eng.)	40
Pashmaran (P.)	424	Peanut (Eng.)	63
Pasumunnai (Tam.)	389	Pearl ash (Eng.)	531, 532
Pasupu (Tel.)	325	Pecari (Eng.)	465
Pasupuvarne (Tel.)	509	Pechak (B.)	534
Pat (B.)	534	Pechaka (Pers.)	340
Pata (Tel.)	320	Pedaru bazara (H.)	533
Patala (S.)	274	Peddadumparashitrakamu (Tel.)	274
Patalaganda (S.)	397	Pedda gomru (Tel.)	675
Patalagandhi (Tel.)	397	Peddajana (Tel.)	500
Patalagaruda (S. & Tel.)	397, 604	Pedda-jila-kurra (Tel.)	176
Patalatumbari (Bo.)	500	Peddamanu (Tel.)	493
Pata-sij (B.)	673	Peddamatti (Tel.)	508
Patchaiyarissi (Tam.)	507	Pedda-neredu (Tel.)	686
Patchak (Chinese)	403	Pedda-palleru (Tel.)	681
Patchapesalu (Tel.)	519	Peddarellu (Tel.)	519
Patchouli (Eng.)	613	Peddayelaki (Tel.)	494
Patch pan (Bo.)	581	Peddayippa (Tel.)	356
Patejatek (Vern.)	616	Peddayita (Tel.)	519
Paterchur (B.)	501	Peddi mari (Tel.)	673
Paternoster pea (Eng.)	260	Peet berela (Vern.)	409
Patharchuri (B.)	498, 595, 603	Peikchin (Burm.)	682
Pathar phori (H.)	333	Pekankai (Tam.)	354
Pathi (S.)	386	Penglajari (Kumaon)	424
Pathorchur (H. & Bo.)	501	Penneru (Tel.)	437
Pathri (Bo.)	512	Pennyroyal (Eng.)	639
Pathya (S.)	688	Penquin (Sing.)	672
Patika (S.)	320	Penteveduru (M.)	287
Patinebu (B.)	130	Pentiveduru (Tel.)	288
Patis (Kash.)	56	Pepar (Mal.)	508
Patna opium (Eng.)	207, 212	Pepiya (B.)	309
Patola (S. & Bo.)	528, 549, 688	Peppermint (Eng.)	36, 51, 196, 198, 199, 200, 514, 638
Patolam (Mal.)	528	Perala (B.)	521, 602, 683
Patolamu (Tel.)	688	Peralu (Mar.)	395
Patoli (S.)	526	Perambu (Tam.)	596
Patsan (H.)	510, 604	Peramutiver (Tam.)	681
Pattai (Tam.)	279	Perarattai (Tam.)	274
Patta karie (S.)	557	Perasatta (Mal.)	274
Patti (Tel. & Vern.)	89, 509	Perettaikkiray (Tam.)	511
Patton-ki-send (H.)	673	Pericham (Tam.)	519
Patrabunga (S.)	664	Periploca of the woods (Eng.)	336
Pattudu (Tel.)	605		

Periyaitcham (Tam.)	.....	519	Phenilamu (Tel.)	....	523
Periya-yelakay (Tam.)	....	144	Phitkari (H.)	....	531
Periyayelam (Tam.)	....	494	Phophal (Guj.)	.....	281
Periya yelumichai (Tam.)	.....	130	Phu (Greek)	..	253
Persian lilac (Eng.)	.....	363	Physic nut (Eng.)	.....	304
Perugilal (Tam.)	..	322	Piala (Vern.)	..	460
Peruku (Mal.)	....	322	Piasal (B.)	..	527
Perumarundu (Tam.)	....	284	Pichakam (Mal.)	....	512
Perumarunna (Mal.)	.....	284	Pichhila (S.)	..	353
Perunanal (Tam.)	.....	519	Pichi (Tam.)	.....	512
Perunde codie (Tam.)	....	669	Pichli (Mar.)	..	263
Perunerunji (Tam.)	.....	518, 681	Pichuka (S.)	....	395
Perungayam (Tam.)	....	174	Pidya (S.)	..	313
Perunkilangu (Tam.)	..	284	Pigavi (Mar.)	....	313
Perunkilannu (Mal.)	.....	284	Pigeon (Eng.)	..	535
Perunshiragam (Tam.)	....	219	Pigweed (Eng.)	..	297
Perun-tutti (Tam.)	.....	661	Piippali (S.)	..	601
Peruppi (Tam.)	..	493, 595, 603	Pikekshana (S.)	....	353
Peruvarai (Tam.)	.....	288	Pikunkai (M. & Tam.)	354, 513, 546, 677	
Peruvian bark (Eng.)	..	111	Pila berela (H.)	..	409, 425
Pes (H.)	.....	537	Piladhatura (Dec.)	..	283
Pesab (H.)	..	538	Pilajari (Kumaon)	....	424
Pesupuvanna (Vern.)	.....	568	Pilakaner (Bo.)	....	425
Petari (Goa)	....	661	Pilakanir (H.)	.....	425
Petha (H.)	.....	497	Pilala (Bo.)	..	508, 597
Pethra (Kash.)	..	195	Pilapalam (Tam.)	.....	496
Petluppu (Tel.)	..	683	Pilchi (P.)	..	687
Petthri (P.)	..	195	Pile-har (H.)	..	688
Pevetti (Mal.)	.....	436	Pilkhan (H. & P.)	.....	508, 597
Peyamrytam (Mal.)	..	427	Pillivendramu (Tel.)	....	437
Peyara (B.)	....	521, 683	Pilo (Vern.)	.....	427
Peyatti (Tam. & Mal.)	..	508	Piloharle (Bo.)	....	688
Peykkumutti (Tam.)	..	128	Pilpil (Pers.)	..	682
Peykommutti (Mal.)	..	128	Pilvalakaner (Bo.)	....	425
Peyppalai (Tam.)	..	431	Pimpal (Bo.)	.....	674
Peypichukku (Tam.)	..	354	Pimplici (Mar.)	....
Phala (S.)	.....	313	Pinak (S.)	..	441
Phalasa-cha-jhada (Mar.)	.....	301	Pinang palm (Eng.)	.....	281
Phalgu (S.)	.....	497	Pinarichanganguppi (Tam.)	....	500
Phalijari (P.)	.....	424	Pinda karakkay (Tel.)	.....	688
Phalinda (H.)	....	686	Pinda-kharjura (S.)	.....	519
Phalsa (H., P. & B.)	.....	509, 601	Pindar (H.)	....	544, 596
Phanas (Bo.)	.....	496	Pindinatta (S.)	..	395
Phanasa-alamba (Cutch & Bo.)	.....	655	Pine (Eng.)	.....	41, 222, 223
Phanasa-alambe (Bo.)	.....	603	Pine-apple plant (Eng.)	....	567
Phanihantri (S.)	.....	397	Pinga (S.)	.....	325
Phanija (S.)	.....	598	Pinna mulaka (Tel.)	..	686
Phaphor (P.)	.....	251	Pinnarpuli (Mal.)	.....	509
Phaphra (H.)	.....	557	Pinnayippa (Tel.)	.....	357
Phapkar (P.)	.....	557	Pinsttarini (M. & Tam.)	.....	472, 537
Pharenda (H.)	.....	686	Pinvala dhotra (Mar.)	.....	283
Phashanveda (Bo.)	.....	181, 509	Pinya (S.)	.....	313
Phayouii (Burm.)	....	668	Pipal (H., P. & Pers.)	598, 601, 674, 682, 688	
Phenila (S.)	.....	523, 601	Piper leaf (Eng.)	.....	376

Pipili (Tam. & Tel.)	.....	682	Plaster of Paris (Eng.)	.....	532
Pipla mol (Nep.)	.....	682	Poal-chhata (B.)	.....	656
Piplamul (H., P., B. & Bo.)	..	520	Podapatri (Tel.)	.....	336
Pipli (Bo. & Guj.)	.....	508, 682	Podophyllum (Eng.)	.....	9, 228
Piplo (Bo.)	.....	674	Pogaku (Tel.)	.....	679
Pippali (S. & Mal.)	.....	520, 598, 682	Poguntig (Lepcha)	.....	665
Pippallu (M. & Tel.)	..	520, 598	Poison berry (Eng.)	..	41
Pipul (B. & Bo.)	..	674, 682	Poisonous plants (Eng.)	.....	539, 593
Pipur (Bo.)	.....	674	Poka (Tel.)	..	281
Pirangi chekka (Tel.)	.....	685	Poliyarala (Malay)	..	681
Pira saram (Tam.)	.....	522	Polla nuvvulu (Tel.)	..	685
Piray (Tam.)	.....	526	Poma (Assam)	..	311
Piriengo (Nep.)	.....	680	Pomegranate (Eng.)	.....	454
Pisa (Bo.)	..	263	Pomponia (Uriya)	..	681
Piscicidal plants (Eng.)	..	583	Ponaku (Tel.)	..	526
Pisha (Mar.)	..	263	Ponga (Tam.)	..	388
Pismarum (H.)	..	560	Pongalam (Mal.)	..	522
Pissa (Mar.)	..	263	Ponguyet (Burm.)	.....	667
Pissidam (Tam.)	..	363	Ponkoranti (M.)	..	599
Pita (S.)	..	290	Ponua (Mal.)	..	316
Pitabhringi (S.)	..	599	Ponna-chettu (Tel.)	..	667
Pita-chandana (S.)	..	290	Poonagam (Mal.)	..	358
Pitadaru (S.)	..	289, 290, 293, 605	Ponnam-pennarava (Mal.)	..	601
Pitakari (Bo. & Mar.)	..	431, 680	Ponnan-gottai (Tam.)	.....	523
Pitaphala (S.)	.....	267	Ponnan-kotta (Mal.)	.....	523
Pitasara (S.)	.....	270, 522	Ponni (Mal.)	..	358
Pitalvaka (S.)	.....	290	Poor man's treacle (Eng.)	.....	253, 271
Pitavaluka (S.)	..	325	Popai (Dec.)	.....	309
Pitcha (Tam.)	.....	596	Popaiya (H.)	.....	309
Pithavana (H.)	..	520	Popal (Pers.)	..	281
Pithvan (H.)	.....	606	Pophali (Mar.)	.....	281
Pitika (S.)	.....	290	Poppy (Eng.)	40, 203, 204, 205, 206, 207, 208	
Pitkari (Dec.)	.....	431	Porasan (Tam.)	..	301
Pitmari (Bo.)	.....	431, 680	Porash (B.)	.....	688
Pitohri (H.)	.....	194	Poris (Tam.)	.....	688
Pitpapara (H.)	.....	674	Porush (H.)	.....	688
Pit-papra (H., Bo. & Pushtu)	.....	519, 674	Post (H.)	.....	204, 207
Pitras (B.)	.....	325	Postakatol (M.)	.....	547
Pitsal (B.)	.....	522, 599	Postdoda (H.)	.....	202, 204
Pittaghi (S.)	.....	427	Post-i-koknar (Urdu)	..	204
Pittamata (S.)	.....	389	Postil (Kash.)	.....	687
Pittpapra (Bo.)	.....	674	Postkhai (Kash.)	..	402
Pittvel (Mar.)	.....	230	Posto-dheri (B.)	.....	202
Pituka (S.)	.....	312	Posuku (Tel.)	..	524
Pitz (Kash.)	.....	606	Potaki (S.)	.....	603
Pivalatilavana (Bo.)	.....	321	Potagohum (Oriya)	..	598
Piwar (Mar.)	.....	497	Potal (B.)	.....	549
Piyaj (B. & Bo.)	.....	494, 600, 662	Potala (Bo. & Guj.)	.....	528, 549, 688
Piyal (H. & B.)	.....	498	Potari (B.)	.....	492, 595, 603, 661
Piyalaka (S.)	..	498	Pot-lunu (Sing.)	.....	683
Piyas (Assam)	.....	662	Potol (B.)	.....	528, 688
Piyaz (H. & Pers.)	.....	494, 600, 662	Potti dumpa (Tel.)	.....	675
Plaksha (S.)	.....	508, 597	Potti-luppu (Tam.)	.....	683
Plantation ginger (Eng.)	.....	256	Povale (Bo. & M.)	.....	535

Prabhakara (S.)	306	Punarnava (S., Bo. & Tel.)	297
Prachina (S.)	320	Punarnavi (S.)	528
Prakirya (S.)	388	Pundharighentuli (Mar.)	528
Prakka (Tel.)	281	Pung (Mar.)	281
Pranada (S.)	506	Punir (H.)	436
Prasaram (Bo.)	518, 681	Punnag (B.)	667
Prasarani (S.)	518, 681	Punnaga (S.)	667
Prashni (Bo.)	598, 601	Punnagam (Tam.)	667
Pratanini (S.)	320	Punnu (Mal.)	388
Pratshu (P.)	367	Punti-machh (B.)	534
Pravala (S.)	535	Pupal (Pers.)	281
Pravrishtayani (S.)	297	Puraishu (Tam.)	301
Pravrishtenya (S.)	283	Purasha (Tam.)	688
Prickly poppy (Eng.)	173	Purbia (Bo.)	684
Prickwood (Eng.)	363	Purha (Dehra Dun)	412
Pride of China (Eng.)	363	Pur-hali-hulla (Kan.)	672
Pride of India (Eng.)	529	Purikaranja (S.)	388
Prishniparni (S.)	408	Purpuray timur (Nep.)	582
Prithakabija (S.)	436	Pursung (Tam.)	688
Priyakari (S.)	547	Purusha (S.)	274
Priyangu (S.)	521	Purvahung (N.W.P.)	358
Priyunger (S.)	534	Purvarasam (Tam.)	688
Proshti (S.)	302	Pushani kai (Tam.)	497
Proteolytic enzymes (Eng.)	356	Pushtida (S.)	430
Pu (Mal.)	688	Pushtipavira (S.)	430
Puarasu (Tam.)	508	Pusitoa (S.)	507
Pudavam (Tam.)	358	Putchuk (Tam.)	402
Puddum (Assam)	528, 688	Puthkanda (P.)	602
Pudel (M. & Tam.)	196, 605	Putika (S.)	388
Pudina (S., H., B., Tam. & Tel.)	196	Putikaranja (S.)	304, 499
Pudinah (H., Bo. & Pers.)	549	Putlapodra (Tel.)	336
Pudol (M.)	281	Putloo puchie (M.)	534
Puga (S.)	580, 679	Putrajiva (Bo. & Kan.)	520, 522
Pugaiyilay (Tam. & M.)	281	Putranjiva (S., B. & H.)	522
Pugam (Mal. & Tam.)	281	Puttutiruppi (Tam.)	320
Pugamu (Tel.)	281	Putty (H.)	533
Pugi (S.)	513	Puvam (Mal.)	524
Puichengghah (Mal.)	679	Puvarasu (Tam.)	527
Puka yila (Malay)	327	Puvuna (Mal.)	356
Pulakizhanna (Mal.)	327	Pya-ya (Burm.)	678
Pulankilhangu (Tam.)	519	Pyintagar-ne-thi (Burm.)	683
Pulapala (Tel.)	686	Pyrethrum (Eng.)	31, 36, 50, 92, 106, 107, 110, 542, 573
Puli (Tam.)	510		
Pulichai (Tam.)	521	Qakilah-e-kalan (Pers.)	144
Pulikkirai (Tam.)	686	Qasab (Arab.)	287, 605
Puliyam-pazham (Tam.)	667	Qasabhuva (Arab.)	278
Pumagamu (Tel.)	581, 599	Qasabuzzarirah (Arab.)	278
Pu-maram (M.)	602	Qashrul-khash-khash (Arab.)	202
Pumarudu (Tam.)	515	Quassia (Eng.)	51, 218, 219, 294
Punaikkali (Tam.)	320	Quassia wood (Eng.)	217
Punaittitta (Tam.)	508		
Punampuli (Mal.)	297	Rabbit (Eng.)	536
Punarbhava (S.)	49, 297	Race ginger (Eng.)	258
Punarnaba (B.)			

Rachajilledu (Tel.)	306	Rambha (S.)	598, 602
Racha-neredu (Tel.)	686	Ram dataum (H.)	606
Rachi (Bushahr)	146	Rametha (Bo.)	559
Racta-vinda-chada (S.)	507, 579	Ramphal (Bo.)	577
Radix dulcis (Eng.)	183	Ramrupaka (S.)	264
Ragha (Kumaon)	600	Ram-salik (B.)	533
Rahu (H.)	536	Ramsita (M.)	577
Rahuchhishta (S.)	271	Ramtulasa (Bo.)	580
Rai (H., Bo., Tel. & B.)	498, 542, 596, 666, 674	Ramtulshi (H. & B.)	580
Raiga (Tel.)	674	Ramtulsi (H. & B.)	598
Rai-jaman (H.)	606	Ramyaka (S.)	303
Rail (Bo.)	689	Ranachamohachajhada (Mar.)	356
Raini (Dehra Dun)	358	Ranachapadavali (Bo.)	688
Raisarisha (B.)	596, 606	Rana-vara (Sing.)	668
Raja (S.)	323	Ran-bhendi (Bo.)	688
Rajadani (S.)	601	Randhuni (B.)	495
Rajakoshataki (S.)	354	Rang (H. & B.)	443
Rajata (S.)	531	Ranghevada (Bo.)	604
Rajatala (S.)	281	Rangni (Bo.)	686
Rajavaral (Bo.)	532	Ran hald (Bo.)	503
Rajika (S.)	498, 666	Ranparul (Bo. & B.)	549, 688
Rajimatphala (S.)	354	Ranshewra (Bo.)	599
Rajkoshataki (S.)	546	Rantondla (Bo.)	314
Rakhtreora (Mar.)	527	Ras (H.)	294
Rakrappittaghi (S.)	264	Rasagandh (S.)	501
Rakshoghni (S.)	262	Rasagandha (S.)	670
Rakta (S.)	323	Rasanjana (H.)	289
Raktachandana (S., H., B. & Bo.)	522, 599	Rasa-sindura (H.)	450
Raktachandanamu (Tel.)	522	Rasaut (H.)	291, 295
Raktachitra (H.)	385	Rasavanti (H.)	289
Rakta kanchan (B. & Mar.)	497, 600	Rashana (Guj.)	520
Raktakanda (S.)	297	Rasna (S.)	274, 520
Raktanag (S.)	532	Rasona (S.)	271
Raktapatrika (S.)	297	Rasonaka (S.)	271
Rakta-posta (S.)	547	Rasun (B.)	271
Raktapunarnava (S.)	297	Rasvat (H.)	280
Raktapushpa (S.)	274, 297	Ratak (P.)	261
Raktapushpi (S.)	438	Ratambu-sala (Bo.)	674
Raktapushpika (S.)	297	Ratanjot (H. & P.)	508
Raktarenu (S.)	274	Ratisurkha (Kash.)	528
Raktashandanam (Mal.)	522	Ratkihiri (Sing.)	661
Raktasikha (S.)	386	Ratnagandhi (S. & Tel.)	602
Rakta til (B.)	684	Ratoakdo (Guj.)	305
Raktavarshabhu (S.)	297	Ratoon ginger (Eng.)	257
Raktavasus (Mar.)	297	Ratrinamika (S.)	325
Raktika (Tel.)	261	Rattan jog (P.)	543
Raktochita (B.)	385	Rattan jot (P.)	677
Rakt-purna (H.)	297	Ratun (B.)	677
Ralla sunnamu (Tel.)	666	Raupya (S.)	454
Ralli (Santh.)	682	Raupya bhasma (H.)	454
Ramatulasi (Kan.)	516	Rauwolfia (Eng.)	31, 35
Rambal (Bo.)	508	Ravi (Tel.)	674
Ramban (Bo.)	606	Raviprita (S.)	321
		Ravishta (S.)	321

Sarkarei-valli (M.)	546	Scorpion-sting (Eng.)	609
Sarl (Kash.)	520	Sebe (Kan.)	683
Sarpa (S.)	538	Sedhalon (H.)	533
Sarpakshi (S.)	438	Seesaka (S.)	532
Sarpavisha (S.)	474, 538	Segapu (Tam.)	683
Sariva (S.)	187	Segumkati (Bo.)	505
Sarsaparilla (Eng.)	19, 187	Segun (H. & B.)	606
Sarson (H.)	542, 666	Segva (H.)	364
Sarsugadi (Tam.)	284	Sehr (Lepcha)	560
Sasa (B.)	578	Sehund (H.)	507, 556, 597, 673
Sasaka (S.)	536	Seir fish (Eng.)	538
Sasubam (Tam.)	401	Selppa (M.)	545
Sasyaka (S.)	531	Sem (Tam.)	270
Satachi (Mal.)	509	Sembarutti (Tam.)	509
Sata kuppi (Tam.)	216	Sengodiveli (Tam.)	386
Satamuli (H. & B.)	57, 665	Senna (Eng.)	10, 20, 36, 46, 50, 99, 100
Satap (Bo.)	560	Sensandanam (Tam.)	522
Satapushpi (S.)	216	Sepali (Tel.)	516
Sataputi (B.)	354	Sephalika (S.)	516, 594
Sataputitorai (H.)	354	Sepuddy (Mal.)	402
Satavari (S., H. & Bo.)	600, 665	Sera (Eng.)	535
Satavari-mul (Mar.)	665	Serdi (Bo.)	523
Sathi (P.)	684	Serpent poison (Eng.)	537
Sati (B.)	327	Serpent stone (Eng.)	534
Satiana (Assam)	276	Sesame (Eng.)	560
Satium (H.)	276	Sevasu (Tel.)	520
Satyanashi (H.)	283	Sevvajil (Tam.)	312
Satmulu (B.)	595	Seyebasam (Tam.)	293
Satni (H.)	276	Scyilam (Tam.)	357
Satuin (Mar.)	276	Sha (Burm.)	661
Satvin (Bo. & Mar.)	276	Shabju (Burm.)	673
Satwin (H. & Mar.)	276	Shada-buri (B.)	548
Satyadharma (S.)	267	Shadagrantha (S.)	262
Satyanamni (S.)	321	Shahara (S.)	413
Satyanasa (P.)	283	Shaharalodhra (S.)	413
Satyaphala (S.)	267	Shahasfaram (Arab.)	680
Saum (Arab.)	271	Shahshilekha (S.)	391
Sauma (H.)	680	Shahtara (Pushtu)	674
Saumya (S.)	261	Shahtarah (Pers.)	674
Sauna-assar (Bo.)	681	Shailapatra (S.)	267
Saunf (H.)	177	Shair-ul-jin (Arab.)	662
Saurif (S. & H.)	219, 321	Shajna (H.)	364
Sauvarchala (H.)	532	Shajnah (H.)	364
Savaramith (H.)	532	Shajratur rumman (Arab.)	683
Savimadat (Mar.)	421	Shakakul (H.)	665
Savin (Eng.)	566	Shakanarupillu (M.)	504
Savirela (Tel.)	518, 681	Shakar pitam (H. & P.)	557
Savita (S.)	306	Shakha palita (Bo.)	531
Sawdust (Eng.)	30	Shakhotaka (S.)	526
Saya (M.)	601	Shakra pushpi (S.)	509, 579
Sa yo mai (Burm.)	682	Shalangli (P.)	411
Schleshmaghni (S.)	262	Shalaparni (S. & Bo.)	597
Schokeddabb (Arab.)	296	Shali (S.)	518
Scilla (Eng.)	33, 252	Shali dhanya (Vern.)	441

Shallaki (S.)	.....	595	Shika (Bo.)	.....	492
Shalmali (S.)	.....	515	Shikai (Tam.)	.....	492
Shalmalipatraka (S.)	.....	276	Shikaya (Tel.)	.....	492
Shalparni (S. & Bo.)	.....	602	Shikha-mulam (S.)	.....	504, 556
Shama (Arab.)	.....	668	Shikhari (S.)	.....	377
Shambara (S.)	.....	413, 421	Shikhi (S.)	.....	296
Shambirani (M.)	.....	526	Shiklapushpa (S.)	.....	353
Shami (S., B. & Bo.)	.....	521	Shila pushpa (S.)	.....	333
Shampangi (Tam.)	.....	514	Shilarasamu (Tel.)	.....	494
Shamuke (P.)	.....	687	Shilatika (S.)	.....	297
Shandanak kattai (Tam.)	.....	241	Shim (Kumaon)	.....	500
Shandilya (S.)	.....	267	Shimai-agati (Tam.)	.....	668
Shankeshvara (Bo.)	.....	438	Shimai-chamantipu (Tam.)	.....	664
Shankha (S. & Bo.)	.....	538	Shimai-kich-chilik kishangu (Tam.)	.....	675
Shankhagalini (S.)	.....	438	Shimaisapu (Tel.)	.....	92
Shankhahuli (H.)	.....	438, 517, 598	Shimai-shembu (Tam.)	.....	92
Shankhakusuma (S.)	.....	438	Shima-jevanti-pushpam (Mal.)	.....	664
Shankhapusi (S.)	.....	438	Shime-agase (Kan.)	.....	668
Shankha valli (Bo.)	.....	507	Shime-shyamantige (Kan.)	.....	664
Shankhavha (S.)	.....	438	Shindur (Mar.)	.....	358
Shankudra (S.)	.....	425	Shingrota (Mar.)	.....	519
Shapesand (Urdu)	.....	284	Shingshupa (S.)	.....	504
Shaqaqule-hindi (Arab. & Pers.)	.....	664	Shiragam (Tam.)	.....	600
Sharadipushpa (S.)	.....	276	Shirarujam (S.)	.....	276
Sharulzabiha (Arab.)	.....	329	Shiratkuichi (Tam.)	.....	278
Shasaung (Burm.)	.....	673	Shiriari (H.)	.....	296
Shatakunda (S.)	.....	425	Shiri-saru (Tel.)	.....	687
Shatamuli (S. & B.)	.....	496	Shirisha (S.)	.....	493, 595, 600
Shata-vali (Mal.)	.....	665	Shirukurinja (Tam.)	.....	336
Shatavari (Bo. & Guj.)	.....	595, 665	Shiru-nari-vengayam (Tam.)	.....	251
Shatawar (H.)	.....	600	Shiru-noch-chi (Tam.)	.....	690
Shathi (S.)	.....	327	Shiru vavili (Tel.)	.....	690
Shatra (Bo. & Pers.)	.....	674	Shishapa (S.)	.....	504
Shavaka (S.)	.....	687	Shishira (S.)	.....	320
Shavaraka (S.)	.....	413	Shisona (Kumaon)	.....	561
Shazavn-mina (Burm.)	.....	673	Shitapaki (S.)	.....	355
Sheduri (P.)	.....	675	Shitapushpaka (S.)	.....	366
Sheekung (Lepcha)	.....	597	Shitaraj (Arab.)	.....	386
Sheep's sorrel (Eng.)	.....	560	Shitarajehmar (Arab.)	.....	385
Shekkunni (Mal.)	.....	261	Shitarak (Pers.)	.....	386
Shemmuli (Tam. & Mal.)	.....	595	Shitirak (Pers.)	.....	386
Shendri (Bo. & Mar.)	.....	358	Shitrakesurkh (Pers.)	.....	385
Sheora (B.)	.....	526, 601	Shitray (Kash.)	.....	385
Shephard's calandar (Eng.)	.....	555	Shittermul (Arab.)	.....	385
Shepard's delight (Eng.)	.....	555	Shitturridge (Arab.)	.....	385
Shepu (Mar.)	.....	216	Shivadai (Tam.)	.....	194
Shetapushpa (S.)	.....	219	Shivadruma (S.)	.....	267
Shewun (Bo.)	.....	509, 675	Shivamallaka (S.)	.....	421
Shiah-kanta (H. & B.)	.....	514	Shivappunelli (Tam.)	.....	519
Shia-jira (H.)	.....	92	Shivappupostaka chedi (M.)	.....	547
Shialakontha (B.)	.....	283	Shivapriya (S.)	.....	134
Shialkanta (B. & H.)	.....	283	Shiveshtha (S.)	.....	267
Shih (Pers.)	.....	65	Shiwari (Bo.)	.....	689
Shik (Arab.)	.....	65	Shlakshnajira (S.)	.....	379

Shobhana (S.)	----	325	Sialkanta (P.)	----	283
Shokanasha (S.)	----	401	Siamalata (H.)	----	511
Shombu (Tam.)	----	176	Siddhi (H.)	----	89
Shona-makhi (Mar.)	----	98	Sigaram (Tam.)	----	255
Shonapatra (S.)	----	297	Sigarinimbam (Tam.)	----	363
Shonpat (B.)	----	502	Sij (H. & B.)	----	557, 673
Shophaghni (S.)	----	297	Sikhi (H.)	----	173
Shora (H., Pers. & Guj.)	----	683	Siktha (S.)	----	535
Shorakhar (Vern.)	----	532	Silajatu (B.)	----	444, 457
Shoraktri (S.)	----	532	Silajit (S.)	----	457, 531
Shora-mitha (Mar.)	----	683	Silajita (H., B., Bo Guj. & Mar.)	----	457, 531
Shor-gaz (Pers.)	----	687	Silaras (S. & H.)	----	457 494, 595
Shori (B.)	----	327	Silhasara (S.)	----	494, 595
Shoriyanam (Mal.)	----	515	Sillu (Tam.)	----	334
Shothaghni (S.)	----	297	Sima avisl (Tel.)	----	668
Shoti (B.)	----	328	Sima-chamanti-push-pam (Tel.)	----	664
Sh-ouniz (Arab.)	----	680	Simachinta (Tel.)	----	493
Shreyasi (S.)	----	320	Simaidevadari (Tam.)	----	520
Shrigalaghanti (S.)	----	353	Simaikkichilik-killangu (Tam.)	----	510
Shrigali (S.)	----	353	Simailyalavinai (Tam.)	----	308
Shrimudrigida (Kan.)	----	661	Simainayuruvi (M.)	----	606
Shringariti (S.)	----	518	Simaiyaravandi (Tam.)	----	308
Shrinkhali (S.)	----	353	Simaiyatti (Tam.)	----	508
Shrivaraka (S.)	----	296	Simak (P.)	----	409
Shu chi (Chinese)	----	331	Simli (Kash. & P.)	----	530
Shudhakshara (S.)	----	531	Simlu (P.)	----	289
Shudi (B.)	----	677	Sina (Tam.)	----	320
Shukaphala (S.)	----	306	Sinainaivirunji (Vern.)	----	569
Shuk-china (P. & Bo.)	----	685	Sinapis (Eng.)	----	49
Shukla (S.)	----	413	Sindur (B. & Bo.)	----	532
Shuklakanda (S.)	----	271	Sinduri (Darjeeling)	----	358
Shuklasaraka (S.)	----	363	Sinduria (N.W.P.)	----	358
Shuktiparna (S.)	----	276	Singomone (Burm.)	----	426
Shul (Arab. & Pers.)	----	267	Singarota (Bo.)	----	518
Shulamardan (B.)	----	353	Singe-jerahata (H.)	----	533
Shulotkha (S.)	----	391	Singhara (H. & M.)	----	599
Shumeo (B. & H.)	----	253	Singi (B.)	----	538
Shunam (Dec.)	----	271	Singittam (Tam.)	----	333
Shuraka (S.)	----	353	Singyabish (Ind. Baz.)	----	60
Shushani (B.)	----	296	Sinhamukhi (S.)	----	264
Shushma (S.)	----	386	Sinhaparni (S.)	----	264
Shvadanshtra (S.)	----	430	Sinhapatri (S.)	----	264
Shvetagunja (S.)	----	261	Sinnaguruginja (Tel.)	----	261
Shvetochchata (S.)	----	261	Sinni (Tam.)	----	492
Shvettabija (S.)	----	261	Sinsupa (Tel.)	----	504
Shweth-purna (Vern.)	----	297	Sinth (Kash.)	----	668
Shwetkeruee (B.)	----	507	Sinzamanne (Burm.)	----	426
Shyama (S.)	----	427	Siora (H.)	----	526, 601
Shyamalachuda (S.)	----	261	Sip (P.)	----	534
Shyamalata (B.)	----	511	Sipi (H.)	----	537
Shyma (S.)	----	297, 325	Sir (Bo. & Pers.)	----	271, 675
Shyonaka (S.)	----	518, 598	Siragam (Tam.)	----	93
Siakanta (B.)	----	283	Siriphal (H.)	----	267
Siali (P.)	----	330	Siris (H., B. & Bo.)	----	493, 595, 600

Sirola (Bo.)	354	Somlata (H. & B.)	581
Sirphal (H.)	267	Sompa (Tel.)	216
Sir sia-peshane (Pers.)	662	Somraj (H. & B.)	434, 596, 681
Sirudekku (Tam.)	521	Somraji (S.)	596
Siruppunaikkali (Tam.)	598	Sona (H. & B.)	518, 531, 598, 605, 680
Sisa (H.)	532	Sonamukhi (H., B., Bo. & Surati)	98,
Sisu (H. & B.)	504		532, 544
Sitakarni (S.)	264	Sonchal (H.)	532
Sitambel (Mal.)	516	Sonf (Bo.)	219
Sitamma pogu nalu (Tel.)	503	Sonogaravi (Bo.)	559
Sitamrytu (Mal.)	427	Sonp (H.)	176
Sitaphal (H.)	503, 577	Son-pat (B.)	98
Sitaphalam (M.)	577	Sont (H.)	176
Sitavari (S.)	391	Sonti (Tel.)	255
Sitruti (H.)	510, 675	Sopu (Tel. & Guj.)	176, 219
Sitsal (B.)	504	Sora (H. & B.)	532
Sittilai (Tam.)	261	Sorahi (H.)	520
Sittiramulam (Tam.)	386	Sosum (H.)	676
Sitragam (Tam.)	386	Sounf (P.)	219
Sitramular (Tam.)	386	Sourabhi-nimba (S.)	605
Sitrapaladi (Tam. & M.)	507, 579	Sourack (Eng.)	560
Sivadai (Tam.)	517	Sovannamilhori (Tam.)	397
Sivandi (Tam.)	333	Sowa (H., B., Guj. & Eng.)	49, 216, 219
Sivapputtutti (Tam.)	259	Soya (P., Urdu & Kumaon)	216
Siyah-danah (Pers.)	680	Spanish saffron (Eng.)	323
Siyah-daru (Afg.)	680	Spanish squill (Eng.)	251
Siyembela (Sing.)	686	Sparrow (Eng.)	537
Small fennel (Eng.)	569	Sparrow grass (Eng.)	555
Small Indian ipecacuanha (Eng.)	336	Spatikari (S.)	531
Smart-weed (Eng.)	560	Spearmint (Eng.)	196
Smuts (Eng.)	540	Spelane (P.)	308
Smyrna Opium (Eng.)	212	Sphotahetu (S.)	408
Snake (Eng.)	538	Spindlewood (Eng.)	173
Snake-bite (Eng.)	606	Spiny bamboo (Eng.)	287
Snake venom (Eng.)	474	Spirah tarkhlali (Kurram)	67
Snehaphala (S.)	684	Sponge (Eng.)	538
Snigdhajija (S.)	379	Squill (Eng.)	251, 252
Snigdhajiraka (S.)	379	Srigalakanta (S.)	283
Snigdhapatra (S.)	388	Sringaberramu (Tel.)	255
Snuhi (S.)	507, 673	Sringi (S.)	538
Soanjna (H. & P.)	598	Sringiritika (S.)	276
Soap industry (Eng.)	636	Sriphalamu (Tel.)	267
Soapstone (Eng.)	533	Sripnari (S.)	675
Sobhanjana (S.)	364, 598	Srotonjana (S.)	531
Sodiyam (Tam.)	313	Stag's horn (Eng.)	535
Sohaga (H., Bo. & P.)	531, 685	Star anise (Eng.)	220, 221
Sohikire (Tam.)	176	Sthapini (S.)	320
Soi (Kash.)	216	Sthirraga (S.)	290
Sojna (B.)	364	St. Ignatius beans (Eng.)	249
Soma (S. & Bo.)	391, 581	Stinging nettle (Eng.)	561
Somadanam (Tam.)	525	Stinking cedar (Japan)	555
Somaraja (S.)	434	Stink weed (Eng.)	134
Sombu (Tam.)	219	St. John's grass (Eng.)	558
Somida (Tel.)	427, 525	St. John's wort (Eng.)	558

Stokpotsodma (Ladakh)	561	Suni (P.)	511
Stone apple (Eng.)	267	Sunn (H.)	502, 596
Storax (Eng.)	33	Sunna (Tel.)	666
Stramonium (Eng.)	134, 135, 405	Sun spurge (Eng.)	556
Subali (H.)	544	Supari (H., B., Dec., Mar. & Urdu)	280, 281, 370
Subji (Vern.)	89	Supari palm (Eng.)	281
Succory (Eng.)	318	Suparnaka (S.)	276
Suchal (P.)	318	Suparnika (S.)	333
Suchi (P.)	72	Suparvan (S.)	287
Suchipatra (S.)	296	Suphadie-khus (H. & B.)	251
Sudha (S.)	531	Supingala (S.)	313
Sudumstra (S.)	430	Suppari (H.)	281
Sufaid (B.)	386	Supriya (S.)	352
Sufaid mitti (H.)	531	Supushpi (S.)	438
Sufeda (H.)	532	Supyari (H. & Dec.)	280, 281
Sufeddamar (H.)	689	Suraja-mukhi (B.)	510
Sufed-musli (H.)	664	Surajmaki (Bo.)	510
Sufedpankijor (Dec.)	274	Surangi (Mar.)	667
Sufed pathar (H.)	531	Suranjanetalkh (Urdu)	131
Sufed-sanbhalu (H.)	690	Surante (Tulu.)	414
Sufflower (Eng.)	312	Surasa (S.)	528
Sufokji (Vern.)	569	Surasa-vrikshaha (S.)	690
Sugandh (B.)	687	Surinjan (H.)	131
Sugandha (S.)	274	Surinjan-i-shirin (Urdu)	132
Sugandha bacha (B.)	494	Surinjan-i-talkh (P.)	131, 132, 133
Sugandhamuricha (S.)	224	Suriyakandi (M.)	510
Sugandhavacha (S.)	274	Suriyam (Tam.)	306
Sugandhayoga (S.)	274	Surjamukhi (H. & B.)	510, 597
Suhaga (B.)	685	Surjavarta (S.)	509, 579
Sujna (Bo.)	364	Surma (H.)	532
Suka (S.)	537	Surmoyi (H.)	538
Sukali (S.)	534	Surpunka (H.)	667
Sukanu (Mar.)	316	Surva (Guj.)	216
Sukar (Nep.)	597	Suryalata (S.)	321
Sukasa (S.)	502, 578	Surya-mukhi (S.)	510
Sukhchain (Kumaon)	388	Suryavgha (S.)	306
Sukhchein (P.)	388	Sushavi (S.)	92, 598
Sukh-darsan (H. & Bo.)	544	Sutapatra (S.)	296
Sukku (Tam.)	255	Sutasowa (B.)	598
Sukshmapatra (S.)	438	Suteja (S.)	321
Sule-gi (Burm.)	681	Sutgilo (Sind.)	427
Sultana champa (H.)	667	Suthira (S.)	320
Sumach (Chinese)	555	Sutipatra (S.)	276
Sumbi (Kan.)	525	Sutr-sowa (B.)	605
Sumbulu'l-hind (Arab.)	679	Sutti (Bo.)	510, 675
Sum-el-himar (Vern.)	568	Suva (Bo.)	216
Sumlu (H. & P.)	289, 290	Suvarchala (S.)	321
Sumsum (B.)	684	Suvarna (S.)	531
Sunanda (S.)	284	Suvarnavarna (S.)	289
Sunbuluttib (Pers.)	679	Suvedagusuman (Tam.)	306
Sundi (Tam.)	255	Svadumansi (S.)	355
Sungal (Kash.)	687	Svaduphala (S.)	354
Sung-misrie (B.)	506	Svarnajiva (S.)	333
Sungtu (P.)	438		

Svarnalata (S.)	333	Talasi (Guj.)	680
Svarna vanga (S.)	533	Talat-mad (Mar.)	666
Svastika (S.)	296	Talc (Eng.)	532
Svetakanchan (S.)	497, 600	Tale (Santh.)	666
Svetakhadira (S.)	492	Tali (Tam.)	263
Svetakutaja (S.)	530, 606	Talimakhana (Mar.)	353, 665
Sveta kutanja (S.)	599	Talisapatra (S., H. & B.)	660
Sveta punarnaba (B.)	297	Talisapatri (Tel.)	125
Svetashirisha (S.)	493	Talishappattiri (Tam.)	125
Sveta-surasa (S.)	689	Talispatra (Bo.)	687
Swanjan (P.)	689	Tallow (Eng.)	64
Swarana bhasma (H.)	461	Tal-makhana (H. & Bihar)	353, 603, 665
Swarnakshira (S.)	544	Talnoppi (Tel.)	438
Swarnalata (S.)	313	Taltar (H.)	666
Swarnamakshika (S.)	532	Taludalai (Tam.)	501
Sweet birch (Eng.)	179	Tamak (B.)	580, 679
Sweet flag (Eng.)	262	Tamaku (H.)	580, 679
Sweet-scented oleander (Eng.)	568	Tamal (Vern. & Bo.)	509, 568
Swetakond (B.)	395	Tamala (S.)	509
Swet barela (H. & B.)	548	Tamalaka (S.)	125
Swet chandan (S.)	241	Tamalapatra (S. & Guj.)	125, 126
Swet gulab (B.)	523	Taman (Bo.)	546
Swetpunarna (Vern.)	570	Tamara (Mal.)	679
Syonaka (S.)	605, 680	Tamarind (Eng.)	443, 446
Syrian rue (Eng.)	368	Tamarta (M.)	603
Tabashir (H. & Pers.)	288, 665	Tamba (H.)	531
Tad (Mar. & Guj.)	498, 666	Tambakhu (Bo.)	679
Taddai (M.)	599	Tambaku (Bo.)	580
Tadi (Tel.)	688	Tambarki (Nep.)	412
Tadi-chettu (Tel.)	498	Tambol (Pers.)	371
Taen (M. & Tam.)	536, 678	Tambridupari (Bo. & Mar.)	518
Taenu (Tel.)	678	Tambul (Assam)	280
Ta-feng-tzu (Chinese)	415	Tambula (S.)	281
Tagar (H. & B.)	253	Tambulam (Mal.)	371
Tagara (S.)	253, 395	Tambuli (H.)	371
Tagarai (Tam.)	499, 596	Tamel (H.)	500
Tagar-ganthoda (Bo.)	253	Tamil (Mar.)	509
Tailed pepper (Eng.)	224	Tamkai (Tam.)	688
Taivela (Mal. & M.)	509, 579	Tamra (S.)	531
Taj (Bo.)	126	Tamraphala (S.)	270
Takada-singi (Bo.)	523, 560	Tamravalli (S.)	519, 598
Takkolakamu (Tel.)	500	Tan (Burm.)	666
Takkolamu (Tel.)	501	Tanbak (Arab.)	679
Takla (Mar.)	499	Tanbaku (Pers.)	679
Takshakha (B.)	537	Tanbol (Arab.)	371
Tal (S., H., B., Bo. & Sing.)	498, 666, 684	Tandi (M. & Tel.)	527, 688
Tala (S.)	666	Tandi chatomarak (Santh.)	681
Talai (Tam.)	498	Tandi tonda (Tam.)	688
Talaichuruli (Tam.)	284	Tandra (Tel.)	527
Talamuli (B.)	503, 671	Tandra kaya (Tel.)	688
Talamulika (S.)	503	Tandula (Mar.)	518
Tala musli (B.)	671	Tangedu (Tel.)	668
Talanili (Mal.)	518	Tanhari (P.)	377
		Tani (Tam. & Tel.)	688

Tanikoi (Tam.)	688	Tempavu (Mal.)	527
Tankai (Tam.)	600	Temprakku (Mal.)	408
Tan-kana (S.)	685	Tendli (Bo. & Mar.)	314
Tankan khar (Bo. & Urdu)	532, 685	Tendu (H. & Bo.)	505, 596, 600, 604
Tanrik-kay (Tam.)	688	Tenduli (Bo.)	314
Tansy (Eng.)	566	Tenitta (Bo. & Mar.)	519
Tantemu (Tel.)	499	Tentul (B.)	526
Tantusara (S.)	281	Tentuli (Uriya)	686
Tanuvaka (S.)	389	Teori (B.)	194
Tapana (S.)	408	Teppatige (Tel.)	427
Tapasvi (S.)	388	Terpenes (Eng.)	620
Tapioca (Eng.)	547	Tessul (Bo.)	602
Tar (H.)	498	Tesu-ka-per (H.)	301
Taramira (H.)	498	Tctankottai (Tam.)	526, 686
Taravada (Mar.)	668	Tettian (Tam.)	686
Taravadagida (Kan.)	668	Tetu (Bo.)	518, 681
Tarbuj (H.)	596	Tevadaram (Tam.)	312
Tarkha (P.)	496	Tevadari (Tam.)	499
Tarmuz (B.)	596	Thaila ankul (H.)	270
Tarra (Tam.)	509	Thamaga (Assam)	363
Tarwar (H. & B.)	596, 604, 668	Thana (Tel.)	688
Tashmizaj (Arab.)	311	Thandra (Tel.)	688
Tatara (H.)	579	Thauer (Kumaon)	687
Tati-chettu (Tel.)	666	Thani (Tam.)	688
Tatmorang (P.)	518	Thau-ba-ya (Burm.)	669
Tatpalong (P.)	680	Thayilai (Tam.)	79
Tattunua (C.P.)	681	Thazhuthama (Mal.)	297
Tattur (P.)	134	The (Eng.)	80
Taum (Arab.)	271	Theyaku (Tel.)	79
Tavitu (Mal.)	358	Thick-leaved pennywort (Eng.)	351
Tchovanna (Bo.)	397	Thikri (H.)	297
Tea (Eng.)	79, 80, 81, 82, 83, 84, 127, 203	Thikrikajhar (Dec.)	297
Teapat (Ladakh)	146	Thimbawmagyi (Burm.)	602
Tea plant (Eng.)	50	Thohar (H. & Bo.)	673
Teha (Chinese)	80	Thol-kuri (B. & Vern.)	341, 351, 668
Tejanam (Mal.)	287	Thona (P.)	687
Tejomalla (B.)	320	Thon-phiyu (Burm.)	666
Tejomantha (S.)	389	Thoonia loth (H.)	670
Tejpat (H. & B.)	125	Thor (H., P. & Bo.)	557
Tejpatra (S.)	125	Thoralimbu (Mar.)	130
Tel (B.)	684	Thorapimli (Bo. & Mar.)	524, 606, 684
Tela-kucha (B.)	314	Thorn apple (Eng.)	134
Telejadi (Kan.)	500	Thorny bamboo (Eng.)	287
Teleni-makkhi (H.)	472, 537	Thuner (Kumaon)	526, 687
Telkodukki (Tam.)	510	Thuno (H.)	687
Tellachitramulamu (Tel.)	386	Thyme (Eng.)	52, 94, 613
Tella damaru (Tel.)	689	Tia (B.)	537
Tellaginiya (Tel.)	493	Tigemoduga (Tel.)	303
Tellategadda (Tel.)	517	Tiger fat (Eng.)	535
Tellatippatige (Tel.)	427	Tikhi (Bo.)	604
Tellavavili (Tel.)	689	Tikhur (H. & B.)	600
Tellayishwari (Tel.)	301	Tikkamalli (Tam.)	597
Tella-jonna (M.)	548	Tikshanam (H.)	446
Tellicherry bark (Eng.)	342	Tikshnamula (S.)	274

Tiktadugdha (S.)	.....		Tivvamoduga (Tel.)	.....	303
Tiktapushpa (S.)	.....	320	Tiyaram (Tam.)	.....	293
Tiktasi (B.)	.....	507, 556	Tobacco (Eng.)	9, 34, 40, 44, 90, 281, 282,	377, 405, 679
Til (H., P., B., Bo., Vern. & Kumaon)	569,		Todagatti (Tam.)	.....	504
	684, 685		Toinnuatali (Tel.)	..	511
Tila (S.)	.....	684	Tokka (H.)	...	535
Tilaha (S.)	.....	684	Tokmalanga (H.)	..	677
Tilaka (S.)	.....	413	Toluk petta (M.)	..	535
Tila-taila (S.)	.....	684	Tondali (Mar.)	..	314
Tilavana (Bo.)	.....	509, 579	Tonde-balli (S.)	.....	314
Tili (P.)	.....	685	Tonkin musk (Eng.)	...	467
Tilia kachang (Vern.)	.....	57	Tonti (Mal.)	...	526
Til-ka-tel (H.)	.....	684	Toon (Eng.)	..	311, 312
Tilli (Mar.)	...	436	Torai (H., B., Urdu & Kumaon)	354, 546,	513, 677
Tilmin (Santh.)	.....	685	Torbanna (P.)	...	689
Tilora (Sind.)	.....	665	Totilla (Nep. & Sing.)	...	681
Tilparni (S.)	...	321	Toung-than-gyee (Burm.)	.....	683
Timi (S. & B.)	...	538	Trachei (M.)	...	530
Tindisa (S.)	...	676	Tragacanth (Eng.)	.	33, 49, 366
Tinduka (S.)	.....	505, 604	Trano (Ladakh)	...	146
Tinduki (Tel.)	.....	505	Tray (Vern. & Chinese)	.....	80
Tinis (B.)	...	598	Trayamana (S.)	..	604
Tinisha (S.)	.....	598	Tree melon (Eng.)	.....	309
Tinkal (P. & H.)	.....	685	Tree of Heaven (Japan)	.....	555
Tinkar (P.)	...	685	Tree of the Gods (Japan)	.	555
Tinkar tankar (Pers.)	.....	685	Trec turmeric (Eng.)	...	293
Tinnevelley senna (Eng.)	..	98	Tridhara-sehund (H.)	...	507, 556
Tinpani (Mar.)	.....	230	Trifala (H.)	...	441, 443
Tin pyrites (Eng.)	..	443	Trifolio (Goa)	..	679
Tin stone (Eng.)	.....	443	Trikantaka (S.)	.....	430
Tintidi (S.)	.....	686	Trikshura (S.)	...	353
Tintili (S.)	.....	686	Trikundri (Bo.)	.....	528
Tintrini (S.)	.....	526	Trinadhvajjan (Mal.)	.	287
Tipadisam (Tam.)	.....	313	Trinagranthi (S.)	.....	333
Tippili (Sing.)	.....	682	Trinaketu (S.)	.....	288
Tir (H.)	.....	684	Trindhvaja (S.)	.....
Tiritaka (S.)	.....	413	Tripa (Mal.)	.....	596
Tirnutpatchi (Tam.)	...	517, 680	Triparni (S.)	.....	313
Tirukalli (Tam.)	.....	507	Tripatra (S.)	.....	267
Tirunitru (Mal.)	.....	517, 680	Triphal (H.)	..	616
Tiruvachippu (Tam.)	.....	425	Tripata (S.)	.....	517
Tisi (H., B. & P.)	...	512, 546, 677	Tripoti (S.)	...	546
Tita (Assam)	.....	292	Trivrit (S.)	...	194
Titaindarjau (B.)	.....	342	Trivrita (S.)	..	320
Titakunga (B.)	.....	333	Trotu (P.)	...	330
Titamara (Assam)	.....	501	True anise oil (Eng.)	.	221
Titapat (H. & B.)	.....	501	True barberry (Eng.)	.	292
Titari (P.)	.....	560	True napellus (Eng.)	.	59
Tithwan (Kash.)	.....	72	Truffles (Eng.)	.	656
Titir (B.)	.....	535	Trumba shrin (Kash.)	.	557
Tittam (Tam.)	.....	363	Tse (Ladakh)	.....	146
Tittinam (Tam.)	.....	357	Tsur (Kash.)	.....	438
Tittiri (S.)	.....	535			
Tivraja (Arab.)	.....	342			

Tubah (Mal.)	579	Tutham (Vern.)	132
Tuba root (Eng.)	50	Tutia (B.)	671
Tuberculosis (Eng.)	594	Tutiri-chettu (Tel.)	661
Tuberoses (Eng.)	618	Tutta (S. & Malay)	531, 661
Tudavullay (Tam.)	685	Tuttanjana (Vern.)	132
Tuduvalai (M.)	601	Tuttha (S.)	671
Tue (H.)	674	Tutti (M.)	595
Tukakunga (Lepcha)	414	Tutturubenda (Tel.)	492
Tukhmeaharetalkh (Pers.)	342	Tuvan (Tam.)	320
Tukhm-i-balangu (Bo. & Pers.)	677	Tuvarkav (Tam.)	281
Tukhm-malanga (P.)	380, 523, 605, 684	Tvashiti (S.)	352
Tukkadu (Tel.)	389		
Tukm-i-gandna (Kash.)	680	Uhhitalvani (Porebunder)	596
Tulabija (S.)	261	Ubkir (Arab.)	683
Tulaphala (S.)	306	Ubugallam (Tam.)	255
Tulasa (Bo. & Mar.)	517, 680	Uchchinta (Tel.)	685
Tulashi (S., Tam. & Tel.)	680	Uchchiyusirika (M.)	598
Tulashi-gida (Kan.)	680	Udagu (Tam.)	388
Tulasi (S., Tam., Tel. & Mal.)	517	Udalai (Tam.)	316
Tulidun (B.)	685	Udargodi (Tam.)	511
Tulkapyrai (Tam.)	601	Udi (Cutch.)	667
Tulsi (H. & B.)	450, 517, 680	Udid (Bo.)	519, 598
Tulunni (Mal.)	397	Udigai (Tam.)	511
Tuma (Tel.)	661	Udubadi (Tam.)	293
Tumba (Mar.)	512	Uduga (Tel.)	270
Tumbi (Tam.)	505, 600	Udumbara (S.)	508, 604, 674
Tumbu (Tam.)	288	Udumbaram (Tam.)	306
Tumni (Tel.)	512	Uerangyum (Tam.)	457
Tumpukotuveli (Mal.)	386	Uffes (Arab.)	683
Tumtikayi (Kan.)	128	Ugragandha (S.)	262, 271
Tun (P., Urdu, Kumaon & Assam)	311, 312	Ujarkanta (H.)	283
Tuna (H.)	311	Ujli musli (Guj.)	499
Tung (P., B., Kash., Assam & Chinese)	36, 311, 358, 377, 687	Ukshi (Mar.)	667
Tuni (H. & B.)	311	Ulang-karci (M.)	604
Tunkajhar (H.)	311	Ulatchandal (B.)	675
Tunkana (S.)	531	Ulatkambal (H. & B.)	259
Tunna (Bo. & B.)	311	Ulavalu (Tel.)	505
Tunnaka (S.)	312	Ulloka (S.)	534
Tunnam (Mal.)	311	Ulundu (M.)	519
Tunu (Tam.)	312	Ulutkambal (B.)	259
Tupa (Bo.)	311	Uma (S.)	677
Tura (Tam.)	674	Umar (H.)	674
Turachi (Kan.)	527	Umari (Vern.)	569
Turai (Bo. & P.)	354, 513, 677	Umbar (Bo.)	508, 674
Turangari (S.)	425	Umbar gular (Bo.)	674
Turgi (S.)	436	Umbelliferous fruits (Eng.)	611
Turi (H. & Malay)	354, 671	Ummatta (Kan., Tel., Tam. & Mal.)	134
Turmeric (Eng.)	50, 281, 289, 293, 312, 325, 326, 443, 615	Ummughilan (Arab.)	661
Turpeth (Eng.)	51, 194	Una (Sing.)	665
Turtle (Eng.)	535	Unamkodi (Tam.)	602
Tusham (Mal.)	527	Undarbibi (H. & Bo.)	512
Tut (H., P., B. & Bo.)	515	Undi (Bo.)	667
		Undirakanipana (B.)	511
		Undirkani (Bo.)	511

Undra (Tel.)	514	Vad (Bo.)	508
Unmatta (S.)	134	Vada (Mar. & Bo.)	508, 673
Unmattadi (Tam.)	431	Vadaja (Tel.)	262
Unnab (Bo.)	530	Vadam-kottai (M.)	547
Unnu (Mal.)	388	Vadencarna (Tam.)	599
Upachakra (S.)	533	Vadirasi (Tam.)	276
Upadyki (S.)	599	Vadulun (Bo.)	538
Upakunchika (S.)	142	Vadumai (Tam.)	521
Upaleta (Guj.)	402	Vagai (Tam.)	493
Upas tree (Eng.)	279	Vagati (Bo.)	599
Upliakamal (Bo.)	516	Vahisa (S.)	601
Uppili (Tam.)	519	Vahisi (S.)	598
Ur (H.)	534	Vahrangur (C.P.)	313
Uravu (Mal.)	601	Vaidyamata (S.)	264
Urid (H.)	519, 598	Vaidyasinhi (S.)	264
Urine (Eng.)	538	Vaijyantika (S.)	389
Uriya (P.)	330	Vairantak (S.)	421
Uriyippa (Tel.)	357	Vaishakhi (S.)	297
Urthamujiru (Guj.)	379	Vaivarang (Bo.)	506, 672
Uru (Tel.)	270	Vaj (Arab.)	262
Urukelfakur (Pers.)	327	Vajamu (Tel.)	288
Urukesabaghin (Arab.)	325	Vajidantaka (S.)	264
Urukessubr (Arab.)	325	Vajidanti (S.)	264
Urukesufr (Arab.)	325	Vajigandha (S. & Tel.)	436, 437
Ushana (S.)	386	Vajini (S.)	436
Usharbudhavhavhaya (S.)	386	Vajjeturki (Pers.)	54
Ushasuta (H.)	532	Vajra (S.)	353
Usikkala (Tam.)	289	Vajra abhra (S.)	441
Uskia (Tel.)	671	Vajra danti (Bo.)	595
Usri (Kash. & Tel.)	656	Vajrakantaka (S.)	353, 507, 556
Ustabunda (H.)	389	Vajrasthi (S.)	353
Uste (Tel.)	306, 685	Vajra-valli (S.)	669
Ustra (S.)	534	Vakha kaparo (Guj.)	297
Ut (B.)	534	Vakka (Tel.)	281
Utakanta (H.)	505	Vakra (S.)	377
Utalani (Mal.)	316	Vakuchi (S.)	434, 590
Utanti (Mar.)	505	Vakulamu (Tel.)	514
Utarana (Mar.)	330	Valakaka (S.)	537
Utarni (Tam. & Bo.)	330, 598	Valambiri (Mal., Tel. & M.)	340, 510
Utati (S.)	505	Valerian (Eng.)	52, 253, 254, 255
Uthika (S.)	320	Valkala (S.)	279
Utran (H.)	330, 681	Valkataru (S.)	281
Uttamani (Tam.)	330	Vallai-murdu (Tam.)	688
Uttangan (Bo. & P.)	296	Vallarai (Tam.)	352, 668
Uttanjan (H., Bo. & Urdu)	296	Vallari (S. & Tam.)	352, 386, 673
Uttareni (Tel.)	493	Vallika (S.)	320
Uttururi (P.)	330	Vallipanna (Mal.)	650
		Vallippala (Mal.)	431
Vabbula (S.)	661	Valittonti (Mal.)	270
Vach (Dec.)	262	Val-milaku (Tam.)	224
Vacha (S.)	262	Valuka (S. & B.)	597
Vachai (Tam.)	264	Valuluvai (Tam.)	313
Vachirom (Tam.)	507	Valumberi (Tam.)	510
Vachnag (Guj.)	54	Valvet-leaf (Eng.)	320

Vaminta (Tel.)	509	Vashanavi (Tam.)	54
Vana-bhenda (Vern.)	570	Vashanup-pulla (Tam.)	672
Vanadittam (Tam.)	333	Vasika (S.)	264
Vana-haridra (S.)	503, 671	Vastuk (S.)	669
Vanahringataka (S.)	430	Vasu (Mar.)	297
Vanajai (Bo.)	500	Vasuka (H.)	264
Vanama (Tam.)	386	Vata (S.)	508, 604, 673
Vanamalini (S.)	438	Vataghani (S.)	437
Vanamurdhaja (S.)	377	Vataghi (S.)	501
Vana-palandam (S.)	251, 599	Vatari (S.)	271, 408
Vanaraja (S.)	497	Vattakkakkakkoti (Mal.)	333
Vanarajhata (S.)	413	Vattattiruppi (Tam.)	320
Vanavrintaki (S.)	524	Vavadinga (Bo.)	506, 672
Vanchhi kanto (Guj.)	661	Vavala (Mar.)	511
Vanga (Tam.)	681	Vavarang (P.)	367
Vangam (Tam.)	518	Vavili (Tel.)	689
Vanhi (S.)	386	Vavut (Kash.)	685
Vanhimula (S.)	389	Vayalchulli (Mal.)	353
Vanhinama (S.)	386	Vayasolika (S.)	355
Vanhimantha (S.)	389	Vayastha (S.)	355
Vanjula (S.)	401	Vayavarna (Bo.)	502
Vanjulam (Mal.)	401	Vayilettu (M. & Tam.)	529, 689
Vanjulamu (Tel.)	401	Vayu-vilangam (Tam.)	672
Vanjuldruma (S.)	401	Vayuvilanga (Tam., Tel. & Kan.)	506, 597
Vannigaruppam (Tam.)	288	Vedhya (S.)	327
Vansa (S.)	264, 578, 665	Vedivembu (Mal.)	311
Vansha (S.)	288, 505	Vegetable products (Eng.)	492
Vantulshi (S.)	580	Vejani (S.)	391
Vantuvala (Mal.)	397	Vekaria (Bo.)	511
Vanveri (P.)	518	Vekhand (Guj. & Mar.)	262
Varagatrakari (S.)	436	Velaga (Tel.)	508
Varahakarni (S.)	436	Velam (Tam.)	288
Varahikanda (S., H. & B.)	526	Velama (B.)	407
Varahpatri (S.)	436	Veldoda (Mar.)	144
Varaimungil (Tam.)	288	Veldode (Mar.)	142
Varandatri (S.)	325	Veli-parutti (Tam.)	681
Varangi (S.)	325	Velip-paritti (Mal.)	330
Varatika (S.)	535	Velip-parutti (Tam.)	330
Vardara (Bo.)	599, 601	Velkhakar (Guj.)	303
Varnish tree (Japan)	555	Vellai-cadamba (Tam.)	495
Varshabhava (S.)	297	Vellai-damar (Tam.)	689
Varshabhu (S.)	297	Vellai-kungiliyam (Tam.)	689
Varshaketu (S.)	297	Vellai-kunrikam (Tam.)	689
Varuna (S.)	502, 600, 671	Vellaimarudu (Tam.)	421
Vasa (S. & Tel.)	262, 264, 598	Vellai-noch-chi (Tam.)	689
Vasaka (B.)	49, 264, 265	Vellainuna (Tam.)	514
Vasanappillu (Tam. & Mal.)	503	Vellaippolam (Tam. & M.)	501, 670
Vasanvel (Bo.)	501, 600	Vellaippundu (Tam.)	271
Vasara (S.)	397	Vellaipputtali (Tam.)	526
Vaseline (Eng.)	684	Vella kondrikam (Mal.)	689
Vasena (S.)	323	Vella-kunturukkam (Mal.)	689
Vash (Arab.)	262	Vellal (Tam.)	672
Vasha (S.)	264	Vellarikkai (Tam.)	502
Vashampa (Mal.)	262	Vellaynaga (Tam.)	495

Vellerikku (Mal.)	....	....	305	Vikhara (Mar.)	....	....	353
Vellerukku (Tam.)	.....	..	306	Vikorana (S.)	.....	.....	306
Velligaram (Tel.)	.....	..	685	Vikranta (S.)	....	.....	321
Velli kondricum (Tam.)	.	....	689	Vilati-chuna (H.)	.....	.....	531
Velliyya (M.)	... ..	..	532	Vilayatinim (Bo.)	..	..	363
Vellullitellagadda (Tel.)	..	.....	271	Vilayati tamaku (H. & B.)	.....	.....	580
Vellummattai (Tam.)	....	.....	596	Vilayiti mehndi (H. & P.)	.....	598, 605	
Veltura (Tel.)	.....	....	505	Villuvam (Tam.)	....	.....	267
Vembu (Tam.)	....	....	360	Vilva (B.)	....	.....	267
Venda-kaya (Tel.)	..	..	676	Vilvam (Tam. & Mal.)	.....	.....	267
Vendayam (Tam. & M.)	.	528, 582		Vilyadele (Bo.)	.....	.....	371
Vendi (Tam.)	.....	..	597	Vindil (Tam.)	.....	.....	288
Vengaram (Tam.)	..	..	685	Vinyaka (S.)	..	.....	276
Vengayam (Tam.)	..	..	494	Violet (Eng.)	..	.....	98, 614, 618
Vengisa (Tel.)	.....	..	522	Vipitakaha (S.)	....	.....	687
Vengodiveli (Tam.)	..	..	386	Vira (S.)	....	.....	323, 421, 425
Venivel (Mar. & Bo.)	.....	293, 320		Viraka (S.)	..	..	425
Venkaram (Tam.)	.....	....	685	Virataru (S.)	..	.....	353
Vankuda (Tel.)	....	..	680	Viravriksha (S.)	....	..	421, 505
Venkurunji (M.)	..	....	595	Virginian prune (Eng.)	..	....	120
Venoms (Eng.)	.....	..	477	Visaboddi (Tel.)	..	....	320
Ventak-kaya (Mal.)	..	..	676	Visha (S.)	..	..	54
Ventayam (Mal.)	..	..	528	Vishabhadra (S.)	..	..	597
Venu (Mal. & S.)	..	287, 288		Vishaglna (S.)	..	....	270
Vepa (Tel.)	.....	..	360	Vishaghni (S.)	..	....	297
Vera Cruz Sarsaparilla (Eng.)	..	..	187	Vishakarpura (S.)	..	..	297
Veral (Tam.)	....	....	288	Vishala (S.)	.....	.....	545
Veripala (Tel.)	.....	..	431	Vishalatailagarbha (S.)	..	..	270
Verittumatti (Tam.)	....	..	128	Vishalatvaka (S.)	.....	.....	276
Verkadalai (Tam.)	.....	..	63	Vishamachhada (S.)	..	.....	276
Verri nela vemu (Tel.)	....	..	680	Visha-mandala (S.)	..	.....	544
Verri-pala (Tel.)	.....	..	689	Vishamangil (M.)	.....	.....	544
Verusenagalu kaya (Tel.)	.....	..	63	Vishamungil (M.)	.....	.....	596
Vetasa (S.)	.....	....	603	Vishamushitka (S.)	....	.....	363
Veti-uppa (Mal.)	.....	..	683	Vishanika (S.)	....	.....	377
Vetiver (Eng.)	.....	..	613	Vishnugandhi (S.)	.....	.....	507, 604
Vetpalai (Tam.)	.....	....	530	Vishnukaranta (Tel.)	....	..	507
Vetti (Mal.)	.....	....	414	Visnukarandi (Tam.)	....	.....	507, 597
Vettila (Mal.)	.....	.....	371	Vistnaclandi (Mal.)	.....	.....	507
Vettipala (Tel.)	.....	....	431	Vitaraka (B.)	....	..	601
Vettiyati (Tel.)	.....	.....	508	Vitashoka (S.)	.....	.....	401
Veyal (Tam.)	.....	.....	288	Vitex leaf (Eng.)	.....	.....	52
Vibhakara (S.)	.....	.....	306	Vitika (S. & Mal.)	.....	.....	371
Vibhavasu (S.)	.....	....	306	Vitis (Eng.)	.....	..	530
Vibhitaki (S.)	.....	.....	687	Vitreous aloes (Eng.)	.....	....	62
Vichitra (S.)	....	.....	401	Vitunna (S.)	....	.....	296
Vidanga (S.)	.....	506, 597, 672		Vitusi (Kan. & Mal.)	....	.....	671
Vidara (S.)	.....	.....	598	Vivasvana (S.)	....	.....	306
Vidari (S.)	.....	.....	676	Vranakrita (S.)	.....	.....	408
Vidattalai (Tam.)	.....	..	505	Vridhdhatulasi (H., B. & S.)	.....	580, 598	
Videchapana (Mar.)	.....	.....	371	Vridhakarnika (S.)	.....	.....	320
Vijaya (S.)	.....	.....	262	Vriki (S.)	.....	.....	320
Vikarttana (S.)	.....	.....	306	Vrikshaha (S.)	.....	.....	689
Vikaswara (S.)	.....	.....	297	Vrikshikali (S.)	.....	.....	336

Vrischikali (S.)	527, 548	Wood shavings (Eng.)	30
Vrisha (S.)	264	Woolly foxglove (Eng.)	136
Vrittaparna (S.)	388	Wooly-headed gnidia (Eng.)	559
Vrittaparni (S.)	320	Wormseed (Eng.)	50, 65, 639
Vuir (Kash.)	606	Wormwood (Eng.)	71
Vurkati (Sind.)	340	Wothalay (Tam.)	661
Vurtuli (H.)	505	Wrought iron (Eng.)	446
Vyadhi (S.)	402	Wuckoo nar (Mal.)	502, 596
Vyala (S.)	386	Wuras (Arab.)	358
Vyapya (S.)	402		
Vyomavallika (S.)	329	Yabaksara (H.)	443
		Yajnadumbar (B.)	674
Wach (P.)	262	Yaladara (Pers.)	408
Wad (Bo.)	673	Yamanai (Burm.)	675
Waghchi (Pers.)	391	Yamani (S.)	93
Wahiti (Bo.)	595	Yan-zin (Burm.)	683
Wakandi (Bo.)	336	Ya-pin (Chinese)	203, 205
Wall rue (Eng.)	648	Yashada (S.)	533
Wal-patpaadagam (Sing.)	680	Yashm (H.)	532
Wandurhashingi (Mar.)	649	Yashtimadhu (S.)	183
Wangantsuru (P.)	438	Yashtimadhukam (Tel.)	183
Wans (Guj.)	665	Yathi-lan (Burm.)	678
Wanurajah (Bo.)	497	Yavachincha (S.)	283
Warras (Bo. & Mar.)	597	Yavakshara (S.)	532
Wars (Arab.)	358	Yava-kshra (S.)	683
Warted agric (Eng.)	657	Yavaneshta (S.)	271
Wartwort (Eng.)	556	Yavaphala (S.)	288
Warumba (P.)	686	Yebruj (B.)	72
Wasa (Tel.)	262	Yehela behada (Mar.)	687
Water animals (Eng.)	534	Yel (Bo.)	687
Water celery (Eng.)	560	Yelakkai (Tam.)	142
Wattle (Eng.)	36	Yelak-kayalu (Tel.)	142
Wawrung (H.)	672	Yelakki (Kan.)	142
Weather plant (Eng.)	260	Yelam (Mal.)	142
Wee-chhata (B.)	655	Yella (Bo.)	687
Whale (Eng.)	538	Yellow Mexican poppy (Eng.)	283
White aconites (Eng.)	59	Yellow oleander (Eng.)	425
White dittany (Eng.)	556	Yellow oleander (Eng.)	303
White-flowered leadwort (Eng.)	386	Yellow-zedoary (Eng.)	303
White hellebore (Eng.)	10	Yelparas (Mar.)	672
White mint (Eng.)	198	Yennai (Tam.)	518
White murdah (Eng.)	421	Yenugapalleru (Tel.)	81
White pepper (Eng.)	365	Yerba Maté (Eng.)	508
White poppy (Eng.)	202	Yerrajuvvi (Tel.)	305
White shark oil (Eng.)	534	Yerriku (Mal.)	248
White silajit (Eng.)	457	Yetti (Tam.)	248
White squill (Eng.)	251	Yettie-kottai (Tam.)	203
Wilayati-zirah (Bo.)	92	Yingsu (Vern.)	682
Wild endive (Eng.)	318	Yippali (Kan.)	674
Wild ipecacuanha (Eng.)	230	Youngzalai (Burm.)	676
Wild liquorice (Eng.)	186, 260	Youn-padi-si (Burm.)	601
Wild tobacco (Eng.)	559	Ysjudemaram (M.)	330
Wintergreen (Eng.)	51	Yugaphala (S.)	276
Wood charcoal (Eng.)	531	Yugmaparna (S.)	515
		Yusham (Mal.)	

Zaafaran (H.)	323	Zatud (Ladakh) ...	561
Zabanekunjashetalkh (Pers.)	342	Zebu (Eng.)	465
Zaghu (Pers.)	677	Zecra (H.)	93
Zahafaran (Arab.)	323	Zedoary (Eng.)	327
Zajul-akhzar (Arab.)	671	Zeharmohra (H.)	535, 536
Zake-sabz (Pers.)	671	Zero (Sind.)	93
Zakhmihaiyat (P.)	427	Zidabi (Mar.) ...	314
Zaminkand (H.)	494	Zinian (Pers.) ...	93
Zanda bidastara (Bo.)	534	Zira (H. & Pers.)	92, 93
Zangihar (H.)	688	Zira-siah (P.) ...	92
Zaravandehindi (Arab. & Pers.)	284, 664	Zira-sufed (P.) ...	93
Zarbuti (P.)	329	Zirishk (Pers. & P.)	289, 292
Zarda (Urdu)	377	Zirnuh birmi (H.)	687
Zardchobah (Pers.)	325	Zufah-yabis (H.)	601
Zardkunel (H. & Bo.)	425	Zufah (Urdu)	601
Zarsud (Arab.)	325	Zurambad (Arab.)	327
Zatakasturika (S.)	676		

Bornyl camphor	123	Cantharidates	472
Brahmine	341	Cantharides	32, 33, 472, 537
Brassicasterol	435	Cantharidic acid	472
Bromo-iso-valeryl urea	27	Cantharidin	472, 473, 537
Brucine	248, 249, 589	Caoutchouc	208, 276, 307, 310
Butain	302, 303	Caperatic acid	645
Butaldehyde	167	Caproic acid	110
Butanone	651	Caprylic acid	378
Butin	302, 303	Capsaicin	544
Butrin	302, 303	Capsicin	544
Butyl butyrate	167	Caramel	319
<i>o-n</i> -Butylharmol	369	Caraway oil	92, 93
Butyric acid	101, 110, 651	Carbarsone	27
Butyric aldehyde	171	Carbonate of soda	532
Buxinamine	544	Cardol	408, 555, 577
Buxindine	544	Carene	224
Buxine	544	α - and β -Carene	520
		Caricin	310
Cadinene	195, 313, 510	Carotene	103, 310, 326
Cadinol	313	β -Carotene	110, 310
Caffeine	20, 26, 79, 80, 81, 83, 84, 319	<i>neo</i> - β -Carotene U	310
Caffeine chlorogenate	83	Carotenoides	110, 303
Caffeine citrate	79	Carotin	241, 510
Cajuput oil	67, 678	Carpaine	310
Calci hydroxide	666	Carpasemine	310
Calcii carbonas	531	Carposide	310
Calcii hydras	531	Carrotal	504
Calcii sulphas	531	Carvacrol	94, 501, 517
Calci oxide	666	Carveol	92
Calcium gluconate	25, 27	Carvinolin	645
Calcium glucono-galacto gluconate	27	Carvone	92, 93, 216, 217, 639
Calcium lactate	26	<i>d</i> -Carvone	216
Calcium oxalate	44, 92, 100, 126, 227, 232, 235, 307, 337, 523	Caryophyllene	126, 517
Calcium oxide	531	Cassia oil	635
Calophyllic acid	694	Castor oil	24, 52, 93, 236, 237, 238, 677, 683
Calophyllolide	694	Catechin	235, 492
α - and β -Calotropeols	307	Catechol	401, 408, 494
Calycopterin	308, 309	Catechutannic acid	492
Camphene	195, 263, 328, 378, 403, 517	Cathartic acid	98, 234
<i>d</i> -Camphene	257	Cedarwood oil	220
Campheride	275	Cedrelone	313
Camphor	18, 19, 20, 32, 33, 50, 67, 69, 71, 120, 121, 122, 123, 124, 224, 275, 285, 291, 328, 419, 429, 613, 703	Celastrine	314
<i>d</i> -Camphor	125, 693	Centellic acid	694
Camphor oil	623	Centelloside	694
Canadine	293	Centic acid	694
Cannabidiol	87	Centoic acid	694
Cannabinol	86, 87	Cephaeline	230, 232, 233
Cannabinolactone	86	Cepharanthine	8
Cannabiscetin	510	Cerberin	317, 694
Cannabiscitrin	510	Cerberoside	317
Cannibene	87	Cerotic acid	285, 437, 691
		Ceryl alcohol	285
		Cetyl alcohol	437
		Chaksine	31

Chalcone	302	Citrullin	695
Chaulmoogra oil	414, 415, 416, 417, 418,		Citrus oil	624
	419, 420		Citrus pectin	130
Chaulmoogric acid	416, 587	Clerodin	322
Chavicine	520	Coca citrin	161
Chavicol	371	Cocaine	19, 51, 161, 162, 163, 164, 165,	
Chebulinic acid	527		166, 371	
Chelerythrine	706	Cocculin	495
Chelidonine	694	Codaline	429
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